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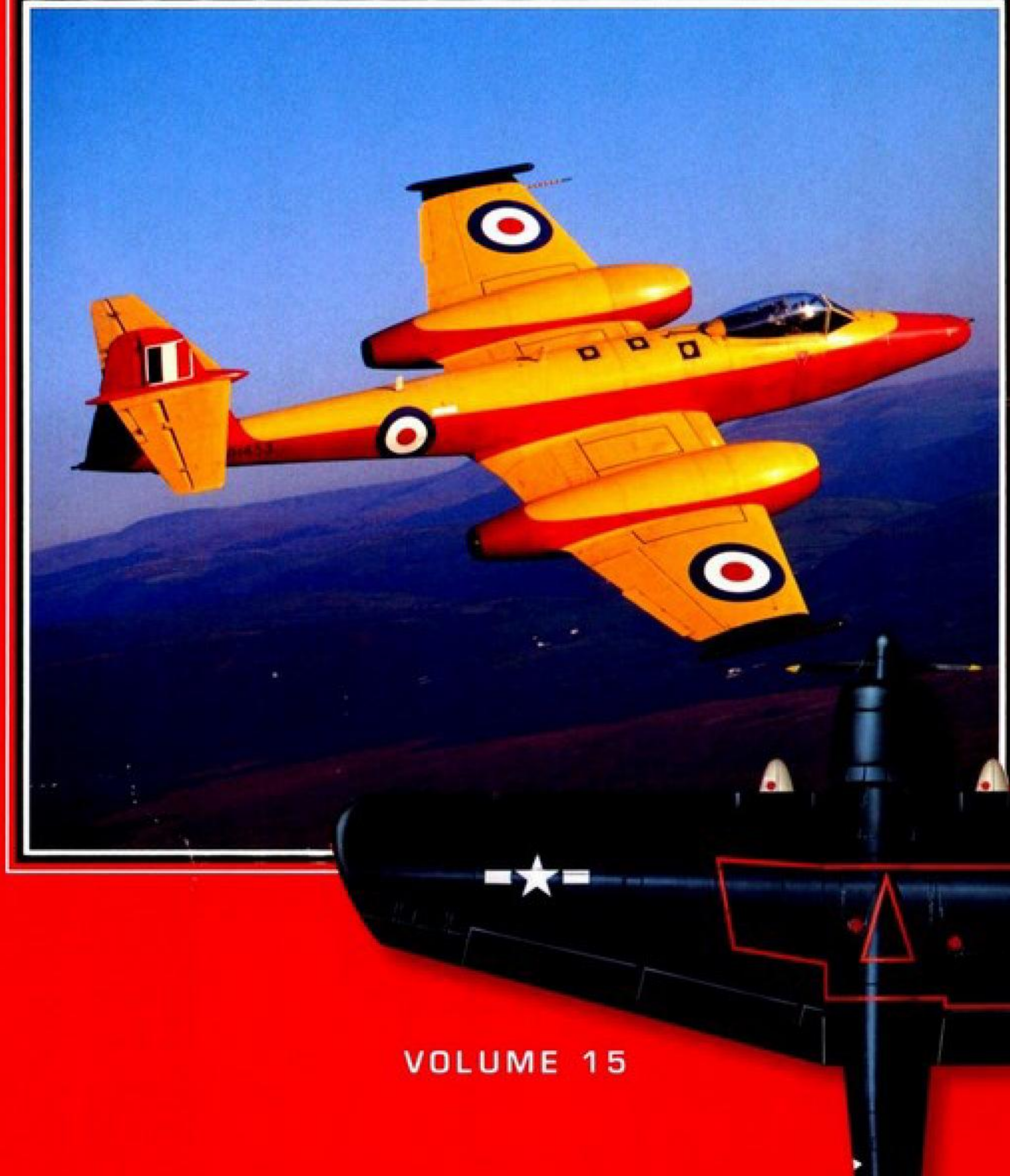

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Editorial Offices:
WINGS OF FAME™
Aerospace Publishing Ltd
3A Brackenbury Road
London W6 0BE, UK
E-mail: info@aerospacepbl.co.uk

Publisher: Stan Morse
Managing Editor: David Donald
E-mail: dave@aerospacepbl.co.uk

Editor: John Heathcott
E-mail: john@aerospacepbl.co.uk

Deputy Editor: Jim Winchester
E-mail: jim@aerospacepbl.co.uk

Sub Editor: Karen Leverington
Editorial Assistant: Tim Senior
E-mail: tim@aerospacepbl.co.uk

US Correspondent:
Robert F. Dorr
Russia/CIS Correspondent:
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Artists: Chris Davey
Mark Rolfe
John Weal
Iain Wyllie

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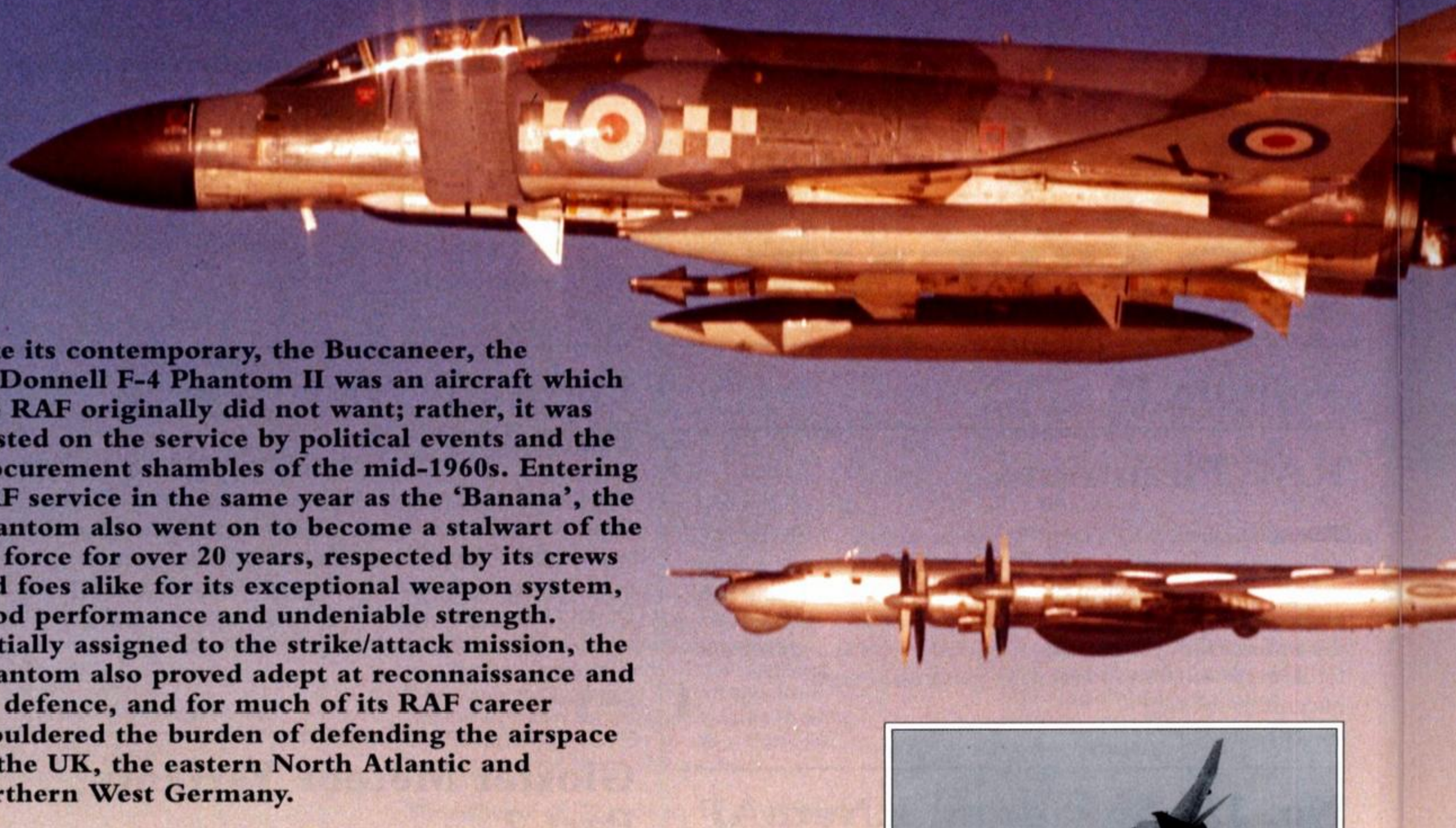
RAF Phantoms



Like its contemporary, the Buccaneer, the McDonnell F-4 Phantom II was an aircraft which the RAF originally did not want; rather, it was foisted on the service by political events and the procurement shambles of the mid-1960s. Entering RAF service in the same year as the 'Banana', the Phantom also went on to become a stalwart of the air force for over 20 years, respected by its crews and foes alike for its exceptional weapon system, good performance and undeniable strength. Initially assigned to the strike/attack mission, the Phantom also proved adept at reconnaissance and air defence, and for much of its RAF career shouldered the burden of defending the airspace of the UK, the eastern North Atlantic and northern West Germany.

In the early 1960s, the British aviation industry had three major projects under way: the AW.681 tactical transport, TSR.2 strike/attack aircraft and P.1154 supersonic VTOL fighter-bomber. In its own way each was a revolutionary design, yet the governments of the day increasingly saw them as expensive luxuries, considering that adequate alternatives could be obtained cheaply from the United States. In the event, all three were cancelled, and the forces were instructed to 'buy American'. The UK aviation industry, then on the brink of producing three world-leading aircraft types, was branded by the Labour government which took office in October 1964 as "a retarded child", and was perceived as consuming far too much of the nation's research expenditure. This position ultimately resulted in the purchase of the C-130 Hercules, F-111K (itself cancelled in early 1968) and F-4 Phantom II.

On 1 July 1964 the British government became the first overseas customer for the McDonnell F-4 Phantom II when it gave the go-ahead for purchase of the F-4K version (FG.Mk 1) for the Royal Navy. This was to be procured in place of the P.1154RN, which had foundered principally due to the failure of the RAF and RN to agree on a common specification. McDonnell had been openly courting both the RAF and, especially, the RN since April 1960, and had already studied the feasibility of putting a British engine, namely the Rolls-Royce RB.168 Spey, into the F-4. The Spey-powered F-4K filled many of the RN requirements, which were principally for a fleet defence fighter, and its price and delivery timescale were attractive. What the RAF really needed at the time was not, however, a fighter, as it already had the Lightning in service. Instead, it required a ground attack aircraft to replace the Hunter. Later, with the cancellation of the F-111, it would also require a tactical nuclear bomber to replace the Canberra, a call answered in the short-term by the Phantom and Buccaneer.

On 2 February 1965, the British government finally cancelled the RAF version of the P.1154. The only viable alternative was the Phantom, and the go-ahead for the F-4M (FGR.Mk 2) was given on 1 July 1965. At the time, the RAF was not pleased, for the Phantom fell far short of the original specification. To operate alongside the Phantom, a militarised version of

Missile Practice Camps at RAF Valley involved live missile launches over the Aberporth sea range. Here a SkyFlash is fired.

The Phantom FGR.Mk 2 and Harrier GR.Mk 1 represented a two-pronged effort to fill the gap left by the cancelled P.1154RAF. Whereas the Harrier was intended to fill the close support role, the Phantom was to have been used on pre-assault 'softening-up' missions and for battlefield interdiction, working behind the enemy's front line. RAF Phantoms were delivered in this dark green/medium sea grey scheme, with the 'last-three' on the fin and Type 'D' roundels.

The Phantom was Britain's first line of defence at the height of the 'Bear' flights. Here an FG.Mk 1 of No. 43 Squadron shadows a Tu-95RT 'Bear-D' which was snooping on NATO manoeuvres. The Soviet patrollers were known to the RAF as 'Zombies', and their activity reached its peak in the late 1970s/early 1980s.

the VTOL P.1127 research vehicle was ordered as the Harrier. Although both turned into capable warplanes in British hands, the RAF then felt the loss of the ambitious P.1154 deeply. The RAF Phantom order was seen as a purely political move to silence the RAF while keeping the unit cost down (through commonality with the Navy's purchase).

To smooth the ruffled feathers of the aviation industry, an abnormally high UK content was specified, the most obvious item being the installation of the Rolls-Royce Spey turbofan. This was not formally specified for the RAF Phantom until November 1965, the service having argued that the extra power of the Spey was not required for land operations, and that the J79-powered Phantom was cheaper and had better general performance. In the event, the Spey was chosen to provide commonality with the RN machines, and to reduce the amount of dollar purchases being made, in the interest of the UK's foreign balance of payments.

The other big players also received palliative contracts, including BAC which built most of the back end of the aircraft, Shorts which built wing sections, and Ferranti which was entrusted with licensed manufacture of the AWG-10 weapon system. Hawker Siddeley's (later BAe's) Brough division was given design/integration authority, a position it held throughout the Phantom's RAF career.

Fitment of the Spey in the FG.Mk 1 entailed a major internal redesign, and was thought necessary to provide enough power for launch from Britain's short-deck carriers and to provide sufficient bleed air for the boundary layer control system. All this was immaterial to the land-based RAF, which noticed only the 10 per cent increase in operational radius (compared to the standard J79-powered F-4), and better low-level acceleration and initial climb rate. The range increase was a boon for the UKADR mission, which involved long-range intercepts, while the extra low-level performance was exploited by RAF Germany air defence units. The Spey installation increased drag, and upset the area-ruled shape of the Phantom. To keep the Spey's costs within pre-agreed limits, lower-grade metals were specified in some areas, in turn reducing maximum speed to Mach 1.9, while medium/high-altitude performance was below that of the J79 Phantom.

Most of the complicated modification work had been performed on the YF-4K naval prototypes, and on 17 February 1967 the first YF-4M took to the air. By the end of the year the first production aircraft had flown. The M differed in only minor detail from the Navy aircraft, the principal differences being deletion of the carrier-specific equipment such as launch bridle attachment points, slotted stabilators and extendable nosewheel, and integration of a

The RAF's Phantom

Preceding the RAF's main batch of F-4M/ Phantom FGR.Mk 2s, the first two aircraft were completed as YF-4M test aircraft.

First flying at St Louis on 17 February 1967, the first YF-4M (XT582) differed little from the main production aircraft which followed. A second YF-4M (XT583) was also produced. The F-4M was based closely on the Navy's F-4K variant, and was externally almost identical. One recognition feature was the F-4K's vertical strip of approach lights on the nosewheel door, which were retained throughout the FG.Mk 1's career. The F-4M also had an unslotted stabilator and a standard F-4C nosewheel strut in place of the F-4K's extendable unit. Internally, the principal difference was the addition of a Ferranti INAS, which was integrated with the AWG-10 fire control system (built under licence by Ferranti) to produce the AWG-12 system. It also had HF radio and radar altimeter. From the outset the F-4M was modified to allow the carriage of SUU-16/A and SUU-23/A centreline cannon pods: F-4Ks were so-modified later in their RAF careers.

Above and below: Two views depict the first YF-4M during testing in the United States. For its first flight the aircraft carried the legend 'Royal Air Force No. 1 F-4M McDonnell' on the nose.

In addition to the Spey Mk 202 turbofans, RAF Phantoms incorporated a significant amount of British sub-systems and sub-assemblies, including BAC-built aft fuselage, fin, rudder and stabilators, and outer wing panels and leading-edge flaps built by Shorts. Much of the avionics suite was also of UK origin, including the ASN-46 navigation computer, built by Marconi under licence from Bendix.

The first F-4M production aircraft flew on 26 December 1967. A total of 116 was completed, with serials XT891 to XT914; XV393 to XV442; and XV460 to XV501.

No. 228 OCU at Coningsby was the first service recipient of the FGR.Mk 2. Below is a line-up of 18 aircraft seen soon after delivery in early 1969, with the famous Tattershall Castle landmark in the background. Many of these aircraft were subsequently used by No. 6 Squadron. Initially wearing no badges, the OCU's aircraft assumed No. 64 Squadron markings (right) in 1970.

'Fighting Cocks'

No. 43 Squadron formed in 1969, taking over the surplus FG.Mk 1 aircraft from the Royal Navy's order. For five years it was the only Phantom unit dedicated to air defence.

The equipment of No. 43 Squadron, the famous 'Fighting Cocks', with F-4s was something of a bonus for the RAF. The aircraft which formed its initial complement were 14 FG.Mk 1s ordered by the Royal Navy, but which were not required by the 'Senior Service' – a decision had been made not to spend money on outfitting HMS *Eagle* for Phantom operations. The RAF was a grateful recipient of the aircraft, having found the Lightning woefully short on range when performing long-range intercepts over the North Atlantic, which virtually always required tanker support. No. 43 Squadron was established at Leuchars in Scotland, the Northern QRA(I) base. The Phantoms joined two squadrons (Nos 11 and 23) of Lightnings, No. 43 beginning operations in July 1969. In March 1970 the unit began standing full alert, and was soon involved in shadowing Soviet patrol aircraft which were, in turn, shadowing NATO naval manoeuvres. In November 1970 the squadron made its first UKADR 'Bear' intercept from a standing alert: the Phantom had come of age in the UK air defence role.

Throughout its Phantom career No. 43 remained at Leuchars, operating the FG.Mk 1. During the early years of F-4 operations crews were trained by the Navy, as they shared a common variant. No. 767 Squadron at Yeovilton undertook the task, although when No. 767 Squadron disbanded in August 1972 this passed to the RAF-'owned' but Navy-operated Phantom Training Flight. Although 228 OCU's syllabus was air defence-orientated from late 1974, FG.Mk 1 crews for the RAF continued to train with the PTF until May 1978, when Navy Phantom instruction came to an end with the impending retirement of *Ark Royal*.

A 'Fighting Cocks' FG.Mk 1 streams fuel from its wing vents. No. 43's Phantoms were especially useful on long-range intercepts.

A four-ship of No. 43 Squadron jets is seen in ferry configuration. The squadron dispatched three aircraft and crews to Cyprus in 1974 to provide air defence expertise to FBSA Phantom crews who had been deployed in response to the Turkish invasion.

Ferranti INAS (Inertial Navigation and Attack System) with the radar/weapon system. The F-4M was also compatible with the SUU-23/A 20-mm cannon pod. Missile armament comprised the AIM-9D (later AIM-9G) Sidewinder and AIM-7E-2 Sparrow. On 20 July 1968 the first F-4M (XT891) was delivered to No. 23 Maintenance Unit, RAF Aldergrove (albeit without INAS). On 23 August it was handed over to No. 228 Operational Conversion Unit at RAF Coningsby, which was to become the Phantom's principal home in RAF service.

Navy surplus

In the midst of the process which equipped RAF strike/attack units with the Phantom FGR.Mk 2, the service also began to operate the FG.Mk 1 in the air defence role under an entirely separate process. The FG.Mk 1 was the Royal Navy's version, optimised for carrier-borne air defence and maritime attack duties. It lacked the Ferranti INAS of the FGR.Mk 2, and was therefore not appropriate for the over-land attack role. The original Navy requirement had been for 143 aircraft, but this was systematically cut as the carrier force was run down, a process hastened by the fire onboard HMS *Victorious* in 1967. In the event, only 50 aircraft (plus seven unexercised options) were ordered, but by the time they arrived in the UK the decision had been made to not equip the second carrier, HMS *Eagle*, for the operation of Phantoms. Consequently, sufficient numbers were required only for the establishment of one front-line squadron (No. 892), one training unit (No. 797) and trials work. Fourteen were deemed 'spare', and were delivered straight to the RAF.

To speed their entry to service, and to avoid complications with the FGR.Mk 2 programme, the FG.Mk 1 crews were trained by the Navy, and remained so until 1978 when the Navy finally ended Phantom operations. The first pilots for the new squadron – the 'Fighting Cocks' of No. 43 – began operations (as the Phantom Conversion Flight) at Leuchars in July 1969, officially becoming No. 43 Squadron on 1 September. The Phantom was a big step up in terms of capability over the Lightning, and the squadron was heavily involved in trials and tactical development work in the early months. Radar-guided missiles were new to the RAF, as was the long-range radar and its associated fire control system. Furthermore, the cockpits and handling were a far cry from those traditionally found in British aircraft. Compared to the

Phantom Training

To prepare for RAF Phantom training, 228 OCU was formed in February 1968, albeit without aircraft. The first arrived in August and were initially used for trials purposes. Training began in earnest in January 1969 when No. 1 Course got under way, this providing the majority of the crews for the first squadron, No. 6. Similarly, No. 2 Course provided the main body of crews for No. 54 Squadron. Most crews for these early courses were already experienced front-line pilots and navigators. Meanwhile, aircrew for the air defence-dedicated No. 43 Squadron and its FG.Mk 1s were trained by the Navy (under the auspices of the PCF/No. 767 Sqn), leaving 228 OCU to concentrate on its strike/attack syllabus, although air combat was included. In 1970 the unit had shadow squadron status bestowed on it, the instructors forming a front-line squadron in time of war. In 1974 the OCU switched to a dedicated air defence syllabus.

The OCU was initially organised into three subordinate squadrons: No. 1 for air combat, No. 2 for strike/attack and No. 3 for ground crew (ex-5 SoTT). In 1983 a reshuffle saw No. 1 Sqn become responsible for simulator/ground school instruction, all flying training then being the province of No. 2 Sqn. When the need for Phantom crews dwindled, the OCU disbanded and the role was continued for much of 1991 by a small flight embedded in No. 74 Squadron.

Towards the end of its existence 228 OCU applied blue tails to its Phantoms. The two-letter 'Cx' codes were adopted when the OCU became the third unit within the Leuchars wing, alongside No. 43 ('Ax') and No. 111 ('Bx') Squadrons.

No. 64's markings consisted of a scarabee, signifying the squadron's ties with Egypt, inside a circle, usually flanked by interwoven red/blue zig-zag markings.

No. 228 Operational Conversion Unit (No. 64 Squadron)

Base: RAF Coningsby, RAF Leuchars (from 22 April 1987)
Officially formed: 1 August 1968
First aircraft: 23 August 1968
Shadow squadron no. assigned: 1 July 1970
Final operations: December 1990
Disbanded: 31 January 1991

Phantom Conversion Flight

Base: RAF Leuchars
Formed: 1 July 1969
Disbanded: 30 August 1969 (became No. 43 Sqn)

Phantom Post-Operational Conversion Unit/Phantom Training Flight

Base: RAF Leuchars
Formed: 1 September 1972 (from No. 767 Naval Air Squadron) to train RN and RAF FG.Mk 1 crews
Last aircraft: 15 March 1978
Officially disbanded: 31 May 1978

Phantom Training Flight

Base: RAF Wattisham
Formed: 1 February 1991
Disbanded: 31 December 1991

No. 38 Group's national commitments saw its Phantoms regularly deploying to former outposts of the Empire. Here, No. 6 Squadron's aircraft are gathered at Tengah.

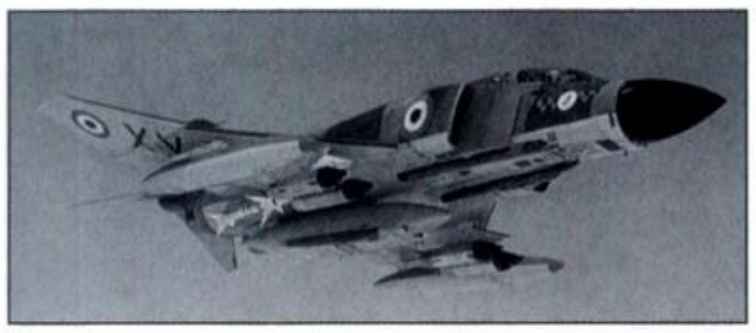
The MATRA 155 (SNEB) rocket was a hard-hitting weapon for use against soft targets, seen here being fired by a No. 6 Squadron FGR.Mk 2. A forward-facing strike camera is carried in the port forward Sparrow recess.

Lightning, the Phantom offered much better range/endurance, and its reliance on the Victor tankers which were also scrambled on live intercepts was much reduced.

No. 43 Squadron was assigned a role within the Northern sector of the UKADR (UK Air Defence Region), and it stood QRA(I) (Quick Reaction Alert – Interceptor) at Leuchars, sharing this task with two squadrons of Lightnings. The Phantom unit was also declared to SACLANT (Supreme Allied Commander, Atlantic) in the TASMO (Tactical Air Support of Maritime Operations) role, which entailed providing fighter cover for NATO operations in the North Sea and Atlantic. In this role, it effectively replaced the 'lost' Royal Navy squadron, albeit operating from a land base. Until late 1974 it was the only RAF Phantom squadron flying in the air defence role.

FGR.Mk 2 into service

As recounted earlier, No. 228 OCU had received its first FGR.Mk 2 at Coningsby in August 1968. The unit had formed in February to prepare for the aircraft's arrival. Airframes arrived apace throughout this period, with about 20 on charge by the end of the year. The latter half of 1968 was taken up with trials programmes, and training did not begin in earnest until January 1969. The crews on No. 1 Course effectively became No. 6 Squadron in May, taking with them some of the OCU's aircraft. No. 2 Course which followed became No. 54 Squadron in September. Both units were designated as FBSA (Fighter-Bomber/Strike/Attack) units, and were assigned to No. 38 Group.

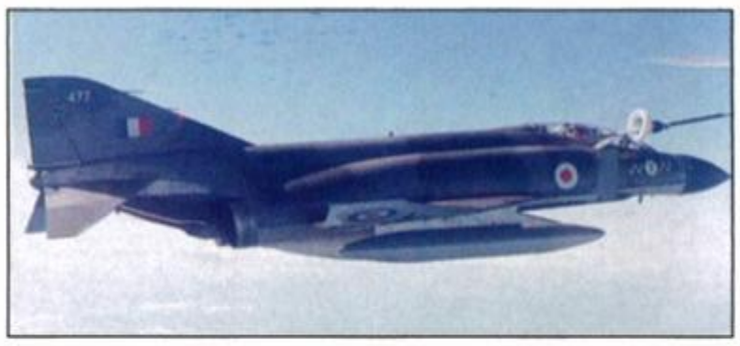


Above: In addition to Sparrows (including acquisition rounds) and SNEB pods, this No. 54 Squadron aircraft carries a centreline EMI sensor pod. Tactical reconnaissance was a secondary role for the unit.

Right: A pair of No. 6 Squadron FGR.Mk 2s launches at the start of a ferry flight. A notable feature of the Spey-engined Phantom was the air spill doors in the belly and the sides of the engine trunks, which were usually open for low-speed flight and when taxiing.

No. 38 Group squadrons

No. 6 Squadron employed a 'flying can-opener' device as its unofficial badge. This was initially presented on the fin but was soon moved to the nose. The Gunner's Stripe adorned the fin.



No. 54 Squadron employed its rampant lion badge on the nose, flanked by blue/yellow checks. The lion was the badge of Flanders, where the squadron had achieved much glory in World War I.

Somewhat surprisingly, the Phantom was first deployed with the No. 38 Group (Air Support Command) rapid-reaction squadrons, replacing the Hawker Hunter. This move, rather than the more obvious choice of sending Phantoms first to RAF Germany, was offset partially by the RAF's assurance to NATO that the Phantoms would be available for deployment in Europe through SACEUR's strategic reserve.

Initially, two units were formed in the FBSA (Fighter-Bomber/ Strike/Attack) role, subsequently joined by a third unit which had tactical reconnaissance as its primary tasking. The two attack units could also perform the recce role, and had a few aircraft equipped to carry the EMI sensor pod. Air defence was a tertiary role.

The three squadrons were kept busy during their Phantom careers, undertaking many overseas trips on both NATO and national tasks, including several deployments to Tengah in Singapore. The FBSA units had only a brief existence before the Phantom was replaced by the more appropriate Jaguar in 1974. The reconnaissance squadron, No. 41, clung on to the Phantom until 1977 while the Jaguar was proven in the reconnaissance role. The displaced aircraft were all reroled for air defence duties.

No. 41 Squadron's badge is the double-armed cross of St Omer, site of the squadron's first overseas headquarters. The badge was carried in full on the nose – with Roman numerals XLI and surmounted by a crown – and flanked by red bars. The cross was repeated on the fin, variously with or without crown.

No. 6 Squadron
Base: RAF Coningsby
Designate squadron formed: 16 January 1969
Official formation: 7 May 1969
Declared operational: 1 August 1969
Disbanded: 30 September 1974

No. 41 Squadron
Base: RAF Coningsby
Official formation: 1 April 1972
Declared operational: 12 July 1972
Disbanded: 31 March 1977

No. 54 Squadron
Base: RAF Coningsby
Official formation: 1 September 1969
Disbanded: 23 April 1974

No. 38 Group was the RAF's rapid reaction force, and worked closely with the Army as part of the UK Mobile Force. It was part of Air Support Command until September 1972, when it was placed under Strike Command control. Although declared to NATO as part of the Strategic Reserve, it also fulfilled national requirements. Together with the other elements of the group, the UK-based FBSA squadrons provided the British Army with a potent air force which could be used in many scenarios.

Brüggen Strike Wing

No. 14 Squadron served in Palestine in World War I, and to signify the idea of a Crusader adopted a winged St George's Cross as its badge. It was worn on the nose, flanked by blue diamonds.

No. 14 Squadron
Base: RAF Brüggen
Designate squadron formed: 1 June 1970
Official formation: 1 July 1970
Phantoms withdrawn: 1 December 1975

No. 17 Squadron
Base: RAF Wildenrath, RAF Brüggen from 16 September 1970
Designate squadron formed: 1 July 1970
Official formation: 1 September 1970
Phantoms withdrawn: February 1976

No. 31 Squadron
Base: RAF Brüggen
Designate squadron formed: 20 July 1971
Official formation: 7 October 1971
Phantoms withdrawn: 1 July 1976

Following equipment of the UK FBSA units, it became the turn of the RAF Germany units to receive Phantoms for the FBSA mission. Based at the 'clutch' airfield of Brüggen, close to the Dutch border, the three squadrons were assigned to 2 ATAF. The principal role was nuclear strike, although the squadrons regularly trained for conventional missions. In 1975/76 the squadrons transitioned to the Jaguar.

No. 17 Squadron's black/white zig-zag chevron was applied on the intake sides, with the squadron badge of a gauntlet presented small on the nose. This aircraft carries the early high-visibility national insignia.

No. 31 Squadron's intricate badge of a five-pointed mullet superimposed on a laurel wreath was worn on the nose flanked by green/yellow checks. The star was repeated on the fin. In the early part of RAF service, Phantoms wore the 'last three' on the fin.

XV463 was one of No. 14 Squadron's first aircraft, and is shown in the short-lived high-visibility national insignia. The unit had previously flown the Canberra B(I).Mk 8 from Wildenrath.

The FBSA squadrons were the spearhead of the force, being used on what is today called battlefield air interdiction tasks. These involved attacking key sites in the enemy's positions prior to an assault, and harassing reinforcement and resupply efforts during the ensuing battle. The Harriers of No. 1 Squadron provided close support, while Pumas and Wessex helicopters moved in troops. The Andover and Hercules tactical transports of No. 46 Group were the transport muscle. Before, during and after the action, No. 41's reconnaissance-tasked Phantoms were the eyes of No. 38 Group.

No. 31 Squadron was another former Canberra squadron, although it had flown reconnaissance-dedicated PR.Mk 7s rather than nuclear strike B(I).Mk 8s. The unit retained a secondary recce role even after converting to the strike Phantom.

For these conventional warfare tasks, the FBSA Phantoms employed SNEB rocket pods, the cannon and free-fall weapons. The latter comprised the standard UK 1,000-lb (454-kg) bomb, available in a range of variants, and, to a lesser extent, the old 540-lb (245-kg) bomb. As much of the work was undertaken at low level, retard tails were fitted to most bombs. For anti-armour work the Hunting BL755 cluster bomb was widely employed. For soft-skinned targets the 20-mm SUU-23/A cannon pod proved to be an excellent weapon, and the Phantom crews became extremely adept in its employment.

A feature of the Phantom which endeared it greatly to the ground attack crews was its ability to fight back if challenged by enemy fighters. Unlike the Hunter, the Phantom carried air-to-air missiles even when loaded with bombs, the Sparrows being given what was essentially a 'free ride' thanks to the Phantom's unique means of carrying the weapons. As well as battlefield duties, No. 38 Group Phantoms also practised against coastal shipping and assault vessels. In the mid-1970s nocturnal attacks were introduced, notably by No. 6 Squadron. One or two flare-ship Phantoms would precede the main formation and toss Lepus flares over the targets, illuminating them for the following fighter-bombers.

During this period the Coningsby Wing had something of a split personality. Declared to SACEUR (Supreme Allied Commander, Europe), it spent much of its time on routine European operations, with numerous squadron visits and exchanges with other European air arms. Armament Practice Camps were staged annually in Malta or Cyprus. However, the Phantoms also had national commitments, and they made regular deployments to Tengah, Singapore. The first of these was undertaken by No. 54 Squadron in December 1969. To underline the importance the UK continued to place in the defence of Singapore (some five years after independence), in May 1970 the Coningsby Wing demonstrated the ability to deploy several Phantoms to the island state non-stop from the UK, flying time being a little over 14 hours.

As far as national commitments went, the only time the Coningsby Wing was called to alert was during the Turkish invasion of Cyprus in August 1974. No. 6 Squadron demonstrated its rapid-reaction capability by deploying to Akrotiri en masse in around 10 hours from notification. No. 54 Squadron followed soon after, although the Phantoms were not called

Nuclear strike

With the cancellation of the F-111K, another burden was placed, albeit briefly, onto the broad shoulders of the Phantom FGR.Mk 2.

It was the cancellation of the P.1154RAF which brought about the procurement of the Phantom FGR.Mk 2 for the Royal Air Force. Following swiftly on the heels of that cancellation was another equally stunning blow to the service: the termination of the BAC TSR.2 project in April 1965. TSR.2 was intended to be the RAF's principal tactical nuclear delivery vehicle, primarily replacing the Canberra B(I).Mk 8s which stood alert in RAF Germany, and the Canberra B.Mk 15/16s which held a similar posture on Cyprus as part of the Middle East Air Force. The TSR.2 was also to have augmented the V-force in a sub-strategic role, and to have provided low-level reconnaissance. It also possessed awesome conventional capability.

With no TSR.2, the RAF was left facing a major gap in its nuclear strike capability and an increasingly urgent need to replace the Canberra. Commitments to NATO had to be maintained, and the Canberra was becoming too slow and vulnerable to perform the vital mission it was assigned. The F-111K was the initial answer but this, too, was cancelled. After the Polaris submarine-launched missile went operational in 1969, the V-force took over the Cyprus detachment: further V-force elements had also assumed SACEUR strike commitments with the retirement of the Valiant. However, neither the Vulcan nor Victor could meet the unique tactical requirements of the RAF Germany strike mission.

The RAFG squadrons regularly got away from the 'clag' of Germany, undertaking regular APCs at the NATO training range at Decimomannu, Sicily. Here, suitably-attired armourers offer up a MATRA 155 pod for SNEB rockets to the CBTE (Carrier Bomb Triple Ejector) on the wing rack of a No. 31 Squadron jet.

A No. 17 Squadron FGR.Mk 2 makes a shallow dive attack using the SUU-23/A gun pod. Owing to the expected nature of the Soviet/WarPac threats, the Phantom units in Germany routinely employed low-level attacks on all missions, be they conventional or nuclear. In a strike attack the weapon would have been delivered using either a low-level toss or low-level, high-speed laydown profile.

A two-pronged Canberra replacement programme was instigated for the RAFG squadrons, beginning in June 1970 with the formation of No. 14 (Designate) Squadron on the Phantom FGR.Mk 2. In July it took over the nuclear QRA alert. By October two more strike squadrons were in place, No. 17 with Phantoms and No. 15 flying the Buccaneer. One more Phantom and one more Buccaneer unit followed to complete RAF Germany's strike assets. Just as the Canberras had been before them, the Phantoms were armed with US-owned tactical weapons, operated under a dual-key arrangement. On the other hand, the Buccaneer was armed with the all-British WE177. By the end of 1970 No. II Squadron was also beginning to work up on the Phantom, principally in the recce role. The sensor pod it used employed several systems originally developed for the TSR.2's reconnaissance pallet.

Whereas the Buccaneer was intended to provide deep-strike interdiction capability, and was not to be replaced until 1983 by the Tornado, the Phantom was mainly tasked with shorter-range missions against any advancing Warsaw Pact forces, a typical time for the single-aircraft sortie being about two hours. In addition to its nuclear strike/peacetime QRA tasking, the fleet was also assigned a similar wide range of conventional interdiction tasks to their cousins in No. 38 Group. Air defence and reconnaissance were secondary roles.

In RAF Germany the Phantom was only ever a stop-gap measure pending introduction of the Jaguar, which took over the nuclear strike, conventional attack and tactical reconnaissance roles from the Phantom, beginning in April 1975. The five years spent by the Phantom on nuclear QRA had been undertaken while the stand-off in Central Europe was as cold as ever, and when any break-out of actual hostilities would almost certainly have involved a considerable exchange of tactical nuclear warheads. That the Phantoms were there, with their readiness and effectiveness unquestioned, was a contributing factor to those hostilities never breaking out.

upon to act other than to monitor the situation. Such deployments required the UK squadrons to be fully trained in air-to-air refuelling.

RAF Germany strike

Nos 6 and 54 Squadrons had formed in the UK first to prove the Phantom in the attack role, and were followed in 1970/71 by three strike/attack units (Nos 14, 17 and 31) and a single reconnaissance squadron (No. II) in RAF Germany, part of NATO's 2 ATAF (Allied Tactical Air Force). Based at Brüggen, the three FBSA units undertook similar missions to the Phantoms of No. 38 Group, with one notable, and more sinister, exception.

Armed with US-owned weapons, the Phantoms sat a nuclear strike QRA, with crews at cockpit readiness ready to launch on strikes against any Warsaw Pact aggression. The Phantom was cleared to carry the B28, B43, B57 and B61 weapons, but it appears that single carriage of the B57 (up to three could be carried) was the favoured option for QRA. RAF Germany's Phantom crews practised hard for the strike task, which usually involved

The Jaguar replaced the Phantom in FBSA squadrons from 1974. Both types are seen here during No. 14 Squadron's transition period, and both are fitted with the CBLS practice bomb carrier.

Examples from each of the Brüggen Wing's squadrons formate for the camera. The toning down of national insignia has not yet reached the underwing roundels of the nearest aircraft.

Photo-Phantom

Flight Lieutenant Jim Anderson flew with both Nos II(AC) and 41(F) Squadrons, tasked with the tactical reconnaissance role.

"We weren't just a reconnaissance force – we were multi-role capable, and with enough hours we could keep up with the GA and AD squadrons. For typical training missions we would take along bombs as well, routinely hitting four recce targets and dropping two bombs – level retard profiles and low-angle dive. We did some strafing as well.

"All reconnaissance missions were flown as singletons. Initially we performed a straight IP to target run, but a high-*g* manoeuvring run-in became the norm, using evasive turns and reversals to approach the target. This made us more difficult to hit, and kept the defences guessing. The aim was to have all the sensors running before you got to the target so that you would get the target on at least one sensor. Visual reporting was important as well, and we would send a report across the HF. Some people preferred to pass further away from the target, which gave a lot of time to acquire the target visually, while others got in close.

The Phantom had a limited night photography capability provided by a flash unit which was carried in a converted fuel tank. It can be seen on the No. II Squadron aircraft above, which is marked with the black/red squadron markings adopted in the interests of lower conspicuity. Below is a No. 41 Squadron aircraft, which performed the tactical recce role for the UK-based No. 38 Group.

The latter gave better imagery, but gave very little time to actually see the target. We routinely carried the wide-angle forward-facing strike camera.

"The fit was good for its time, with five cameras giving almost horizon-to-horizon coverage. Some pilots put a chinagraph mark either side of the canopy just below the horizon to show the upper limits of sensor coverage, thus aiding aiming of the cameras, but that obviously depended on you keeping your head in the same position. When using the IRLS at nights against targets such as bridges, we would sometimes use an offset approach with modest bank. This would render 3-d detail making the photographic interpreters' job easier.

"The infra-red was very good, much better than the unit they put in the Jaguar which replaced us. When it was tuned properly it gave outstanding results, and at night was far better from a tactical point of view than the NIS [Night Illumination System]. The NIS was like a strobe flash system carried in the front and rear of a converted fuel tank, synchronised to the shutters based on the velocity/height calculation. It was not very tactical as it gave the enemy a nice bright shooting point to aim at.

"The SLRR was a useful tool for establishing baseline information after which missions could be flown to monitor the situation, MTI being a valuable asset. The sensor was not roll-stabilised, and the aircraft had to be flown straight and level. Planning for some of these missions became very complicated due to airspace restrictions associated with the border.

"Occasionally we did maritime recce, especially during JMCs when we worked with Vulcan MRR aircraft. The Vulcan would give us a grid reference and the plot of the fleet, and we would go in at low level

As well as illustrating the versatility of the Phantom, with recce/attack/fighter stores, this photograph also provides good detail of the EMI multi-sensor pod. The dielectric panels along the lower corners denote the position of the antennas for the P391 side-looking recce radar.

and do a visual i.d. of the vessels to draw up an accurate picture of which corresponded to which blip on the Vulcan's radar. After we passed through the fleet then might draw in and rearrange itself, losing the long-term value of our mission, but if Buccaneers were running in after us it was very useful – and great fun.

"One of my more memorable missions for getting into close proximity with the Cold War enemy was over the Skaggerak. We picked up two blobs on the radar and went down to investigate. As we broke through the low overcast, there, right in front of us, was *Sverdlov*, *Krivak* and an 'Osa'-class. That was quite a sight.

"'Barrack-bashing' was regular practice, especially in Germany – this involved flying over any potential targets that lay on or near our intended route. Every target was yet more practice for us. We also got involved in trials work, flying over trial camouflage for ground positions. Some of the more elaborate ones, using crops and ploughed fields to hide whole SAM sites, took some finding.

"All in all, the Phantom was an excellent platform – even the sim could be fun! The degree of satisfaction derived from being an F-4 recce 'puke' was immense although it inevitably engendered ribald comments from the 'mud-movers' and the 'pies-in-the-skies' also-rans, usually along the lines of 'Clicky-click, you're dead' and 'Kill them with film'."

singleton low-level attacks. CBLS (Carrier Bomb, Light Stores) pods were an oft-seen fit, enabling the Phantom to carry the 28-lb (12.7-kg) training bomb which mimicked the ballistics of a nuclear weapon. Conventional missions ranged from close support work with forward air controllers, to interdiction tasks. Virtually all attacks were made from a low-level ingress, with low-level dive, toss or laydown profiles. High-angle bombing was never practised, and neither was inflight refuelling.

Reconnaissance

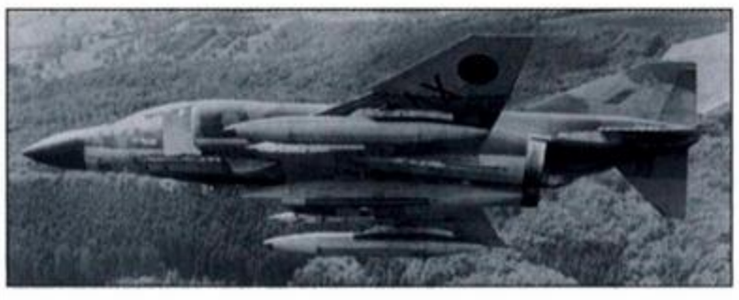
Such missions were a secondary tasking for No. II(AC) Squadron, which formed at Brüggen but took up residence at Laarbruch. This unit was primarily concerned with tactical reconnaissance, for which the Phantom was equipped with an EMI multi-sensor centreline pod. No. II was instrumental in exploiting the considerable potential of the Phantom in this role, allowing it to be far more capable than the Hunter FR.Mk 10s which preceded it. In addition to various combinations of cameras, the EMI pod carried a Texas Instruments RS-700 infra-red linescan and a Royal Radar Establishment/EMI Type P391 side-looking radar. This sensor provided moving target indication, ground mapping or photo-recording functions. The radar image could be recorded on film by a linescan system. For night photography the reconnaissance Phantom carried an outward-facing flash unit in the front of a converted fuel tank, synchronised to the shutters of the four F.135 cameras carried in the pod, but this could only be used at very low level.

Back in the UK, No. 41 Squadron formed in April 1972 within No. 38 Group as the final FGR.Mk 2 FBSA/recce unit. Drawing on the experience of No. II, it rapidly established an excellent reputation for providing timely reconnaissance. No. 54 Squadron in the UK and No. 31 in Germany also had a secondary reconnaissance tasking, although they only received a handful of aircraft with the necessary modifications to carry the sensor pod.

UK air defence

In 1974 the SEPECAT Jaguar became available for the strike/attack mission, and a wholesale re-equipment process began, starting with No. 54 Squadron in April. No. 6 followed later in the year, followed by the RAF Germany units. In March 1977 No. 41 acquired the Jaguar, completing the re-equipment of all former RAF strike/attack/recce units. Many pilots missed the Phantom's innate sturdiness, its air-to-air prowess and good missiles, but the Jaguar was an admirable replacement. Its small

RAFG Recce



No. II marked its Phantoms with its Wake knot badge on triangles on the nose, initially in black/white. These were later presented in black/red to tone down the visibility of the aircraft.

No. II Squadron began working up on its Phantoms at Brüggen, although its operational base was to be nearby Laarbruch. Phantoms replaced Hunter FR.Mk 10s in the tactical reconnaissance role, although the squadron maintained proficiency in the strike/attack role. As the first RAF Phantom recce unit, No. II was instrumental in developing tactics for the new aircraft, which offered considerably increased potential over its predecessor.

No. II(AC) Squadron

Base: RAF Brüggen, RAF Laarbruch from 1 April 1971
Designate squadron formed: 7 December 1970
Official formation: 1 April 1971
Phantoms withdrawn: February 1976

McDonnell Douglas F-4M Phantom FGR.Mk 2
No. 41 Squadron
RAF Coningsby

Although primarily tasked with tactical reconnaissance, No. 41 Squadron also undertook conventional attack duties and, in emergency, could undertake the air defence role. Such versatility in one airframe was the key to the Phantom's success in RAF service, allowing it to be easily re-roled as strategic developments dictated. In addition to the EMI reconnaissance pod, this aircraft is shown armed with Hunting BL755 cluster bombs on the inner wing pylons.

Camouflage
RAF Phantoms were delivered in a standard scheme of NATO dark green and glossy medium sea grey upper surfaces, with light aircraft grey undersides.

Fitting the Spey
The RB.168-76R Spey Mk 202 which powered the FGR.Mk 2 was considerably wider than the J79 turbojet fitted to non-UK Phantoms, requiring some internal redesign. The intakes were also made some 20 per cent larger in capture area to cater for the increased mass flow. The jetpipes were also made larger, consisting of a variable-area primary nozzle and a fixed-area secondary nozzle.

Reconnaissance equipment
Using a centreline pod was an elegant solution to providing a full tac recce capability without the need for a dedicated RF-4. The EMI pod could be reconfigured with a variety of cameras, but usually mounted five optical sensors consisting of one vertical, one forward and two oblique F.95s, and a single vertical F.135. The latter camera had twin lenses which produced a stereoscopic effect when viewed simultaneously. Alternatively, the pod could house an F.126 medium-altitude camera, or an oblique F.95 with 12-in lens. The pod also accommodated a roll-stabilised Texas Instruments RS-700 infra-red linescan, which recorded a heat 'picture' on film (incidentally, these sensors are still in use with the RAF's Canberra fleet). In the sides of the pod were the antennas for the EMI P391 Q-band SLR (side-looking radar), which could produce high-resolution imagery and incorporated a moving target function. For night photography a photo-flash unit could be carried in the nose and tail of a modified fuel tank, but was only effective at very low level.

Fuel
Internal fuel was held in integral wing tanks and six flexible fuselage cells to give an internal capacity of 1,977 US gal (1,646 Imp gal; 7484 litres). Wing drop tanks usually held 370 US gal (308 Imp gal; 1400 litres) each.

Dual controls
FGR.Mk 2s had the ability to fit duplicated controls in the rear cockpit, but this was rarely employed other than for pilot conversion.

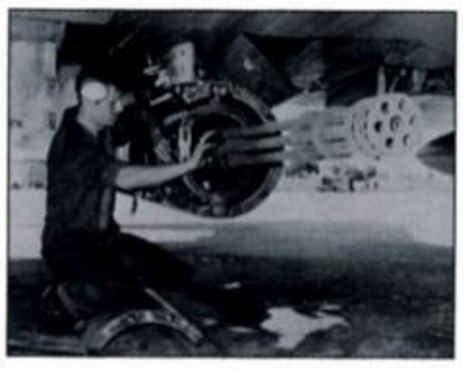
Radar
The FGR.Mk 2 had an APG-59 radar with 32-in (81-cm) radome. The nose radome hinged to the right but, uniquely to the FGR.Mk 2, could also be slid forward on rails.

Braking
The Phantom had powerful brakes made by Goodyear UK with Dunlop anti-skid systems. The arrester hook was strengthened by comparison with other variants, and a chute was housed behind a flip-up cap in the extreme tail.

Keith Fretwell

Phantom weapons

In addition to the four recesses for Sparrow missiles, the FGR.Mk 2 had five stores attachment points. In the attack role the principal weapons were bombs, cluster bombs or rockets. In the strike role up to three B57 nuclear bombs could be carried.



Left: The SUU-23/A gun pod contained a self-driven GAU-4/A 20-mm Vulcan cannon with 1,234 rounds of M50 ammunition of varying types, including HE, API and training.

Above: This heavy loadout of BL755s and AAMs is far from typical, but does convey the power of the Phantom in the attack/air defence roles.

Left: For area attacks the BL755 cluster bomb was widely used. The vanes on the front armed the weapon in mid-air, the container splitting to disperse 147 general-purpose bomblets.

Left: This No. 6 Sqn FGR.Mk 2 is displayed with an array of conventional ordnance including UK 1,000-lb bombs (including Paveway II LGB fin), SNEB 68-mm rockets, AIM-7E-2 Sparrows and AIM-9D/G Sidewinders.

Right: Two US Navy F-4Js were leased to conduct XJ521 SkyFlash trials, undertaken at Point Mugu.

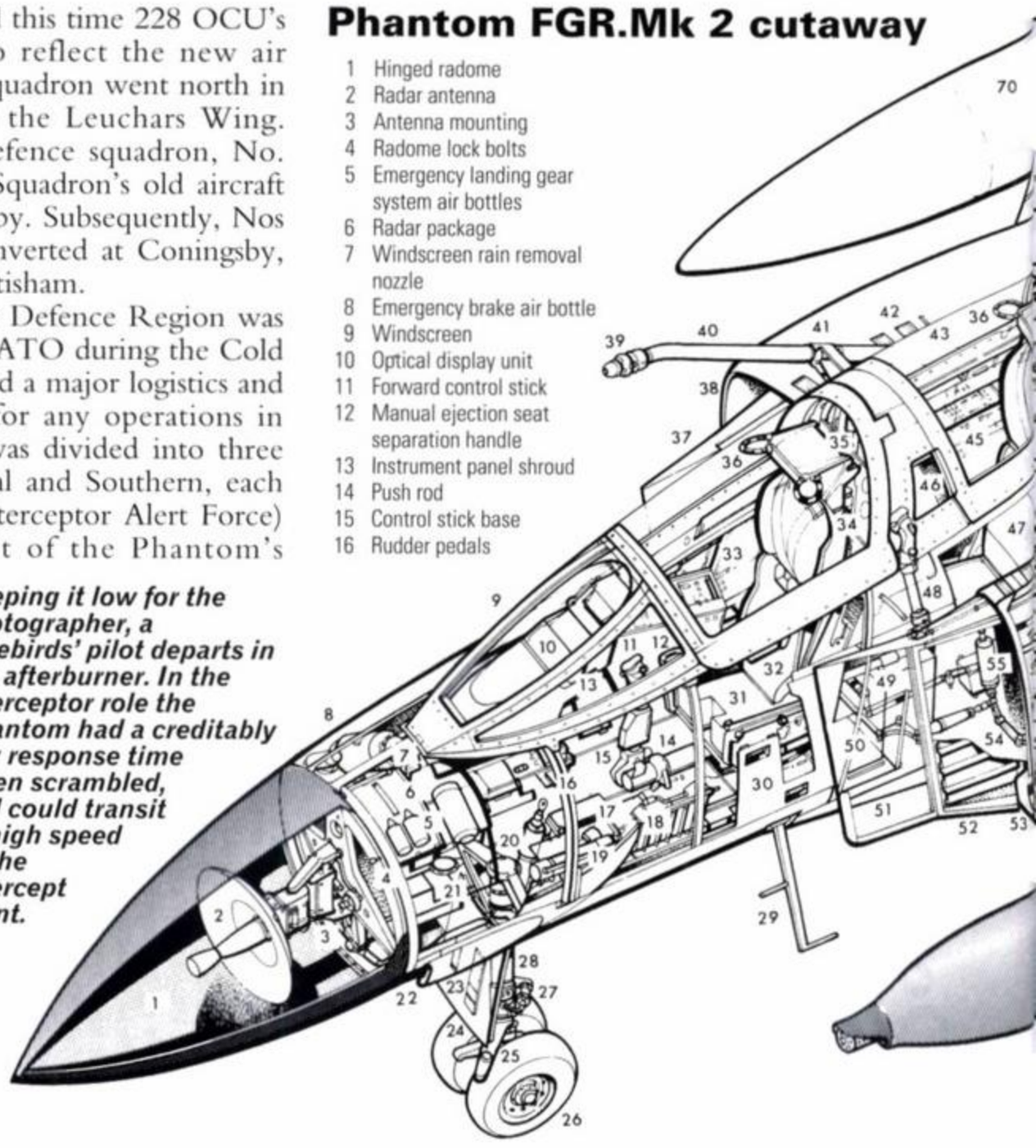
size and smokeless engines made it virtually impossible to see when attacking at low level. Unlike the Phantom, it had been designed from the outset for low-level flight, and was consequently much easier and more comfortable to fly on standard strike/attack missions, with a much better view from the cockpit. Compared to that in the Phantom, the nav/attack system was a vast improvement.

A flood of Phantoms and experienced air/ground crew was released to supersede the Lightning in the air defence role. The process began in early 1974, when No. 54 Squadron's Phantoms passed to No. 111 Squadron. This unit remained at Coningsby until November, by which time the Lincolnshire base had been reallocated to No. 11 Group, which controlled air defence assets. Around this time 228 OCU's syllabus was changed to reflect the new air defence tasks. No. 111 Squadron went north in November to reinforce the Leuchars Wing. The second 'new' air defence squadron, No. 29, formed with No. 6 Squadron's old aircraft and remained at Coningsby. Subsequently, Nos 23 and 56 Squadrons converted at Coningsby, before moving on to Wattisham.

Defending the UK Air Defence Region was a high-priority task for NATO during the Cold War, as Britain represented a major logistics and strategic offensive base for any operations in Europe. The UKADR was divided into three sectors: Northern, Central and Southern, each of which had an IAF (Interceptor Alert Force) assigned. At the height of the Phantom's

Keeping it low for the photographer, a 'Firebirds' pilot departs in full afterburner. In the interceptor role the Phantom had a creditably low response time when scrambled, and could transit at high speed to the intercept point.

Phantom FGR.Mk 2 cutaway



17 Nosewheel drag brace assembly
18 Temperature control assembly
19 Refrigeration unit
20 Nosewheel trunnion
21 Nosewheel command potentiometer
22 Ram air inlet duct
23 Approach/taxi lights
24 Nosewheel leg fairing
25 Torque arm assembly
26 Twin rearward-retracting nosewheels
27 Nosewheel steering power unit
28 Shock strut
29 Retractable steps
30 Entry hand/footholds
31 Seat pan
32 Pilot's ejection seat
33 Pilot's starboard control console
34 Remote rocket initiator
35 Canopy actuating cylinder
36 Face screen handles
37 Variable inlet duct ramp
38 Starboard intake
39 Inflight-refuelling probe nozzle
40 Inflight-refuelling probe (extended)
41 Support arm
42 Bleed air louvres
43 Aft cockpit canopy
44 Canopy actuating cylinder
45 Aft cockpit starboard console (Inertial Nav/Attack System)
46 Inter-cockpit fixed section window
47 Aft ejection seat
48 Aft control stick
49 Electrical equipment rack
50 Bellcrank
51 Fixed ramp
52 Perforated ramp
53 Boundary air bleed vent
54 Intake
55 Ramp actuator
56 LOX converter
57 Aft solid ramp
58 Flight director computer
59 Bleed air louvre assembly (lower)
60 Air data computer
61 Intake duct
62 Bleed air louvre assembly (upper)
63 Hydraulic reservoir
64 Air bottles (canopy/emergency flap)
65 Stabilator control linkage rod
66 Radio receiver/lead computing gyro and amplifier
67 IFF antenna
68 Wing forward structure (integral fuel)
69 Boundary layer control system
70 Starboard external fuel tank
71 Wing rib assembly (main landing gear support)
72 Front spar
73 Outboard pylon hardpoint
74 Main spar
75 Wing-fold hinge
76 Access doors
77 Outboard leading-edge flap
78 Outer wing section
79 Starboard navigation light
80 Join-up light
81 Starboard droop aileron
82 Wing spoilers
83 Outboard rear spar assembly
84 Starboard trailing-edge flap
85 Inboard rear spar assembly
86 Main landing gear trunnion
87 Mainwheel well
88 Fuel filler access
89 Fuel lines
90 Fuselage no. 1 tank
91 Fuselage no. 2 tank
92 Bleed air
93 Fuselage structure
94 Fuselage no. 3 tank
95 TACAN antenna
96 Ram air turbine (extended)
97 Emergency generator
98 Fuselage no. 4 tank
99 Fuselage no. 5 tank
100 Arresting gear actuator
101 Overheat detection sensing element
102 Stabilator bellows assembly
103 Fuselage no. 6 tank
104 Fuselage no. 7 tank
105 Ram air inlet
106 Variable capacitors
107 Starboard stabilator
108 Anti-collision light
109 Pressure pick-up probe and heater
110 Tailfin front spar
111 Tailfin structure
112 HF communications antenna
113 Pitot mast
114 Passive warning RF heads
115 Upper UHF communications antenna
116 Rudder upper hinge
117 ILS localiser/glide path aerial
118 Rudder
119 Fuel vent mast
120 Rear navigation light
121 Drag chute door (tailcone)
122 Stabilator
123 Drag chute housing
124 Stabilator hinge
125 Rudder control cylinder
126 Stabilator power control cylinder
127 Arresting hook uplatch mechanism
128 Cooling duct
129 Force link bellcrank
130 Stabilator feel trim system actuator
131 Trim actuator relay panel
132 Undersurface heat-resistant skinning
133 Variable-area exhaust nozzle
134 Exhaust collector actuating sleeve
135 Auxiliary air door
136 Turbine cooling leakage air/Rolls-Royce Spey 202 turbofan
137 Engine thermocouple harness
138 Engine front outboard suspension point
139 Low-pressure compressor case
140 Air inlet guide vanes
141 Engine accessories (AC generator/constant speed drive)
142 Oil tank
143 Hydraulic reservoir
144 Landing gear inboard door actuator
145 Port mainwheel well
146 Lateral series servo actuator
147 Flow divider
148 Trailing-edge flap-actuating cylinder
149 Access doors
150 Trailing-edge flap
151 Droop aileron
152 Aileron viscous damper
153 Aileron power cylinder
154 Dual servo spoiler valve
155 Droop aileron actuating cylinder
156 Hydraulic line (to wing-fold system)
157 Inboard spoiler cylinder
158 Outboard spoiler cylinder
159 Wing-fold actuating cylinder
160 Wing-fold line
161 Wing outer section
162 Join-up light
163 Port navigation light
164 Compass transmitter
165 Outboard leading-edge flap-actuating cylinder
166 Outboard leading-edge flap
167 Boundary layer control system
168 Wing-fold hinge
169 Torque links
170 Centre leading-edge flap-actuating cylinder
171 Main landing gear shock strut
172 Side brace actuator
173 Main spar
174 Uplock sequence valve
175 Wing fuel tank
176 Centre leading-edge flap fittings/swivels
177 Shuttle valve
178 Hydraulic system accumulator
179 Access door
180 Front spar
181 Wing centre-section fuel tank
182 Centre-section front spar assembly
183 MWA (Multiple Weapons Adaptor) centreline rack
184 SUU-23/A 20-mm cannon pod
185 Twin AIM-9G air-to-air missiles on LAU-7A launch rails
186 Pylon adaptor shoe
187 Port inboard weapon pylon
188 Centre leading-edge flap
189 Port outboard pylon
190 Mainwheel brake assembly
191 Port mainwheel
192 Port external fuel tank (370 US gal/1400 litres)

UK AD units

Aside from the establishment of No. 43 Squadron in the air defence role, in 1969, it was not until the widespread reroling of the Phantom in the mid-1970s that the fighter squadrons transitioned to the type which would bear the brunt of UK air defence operations for 15 years. Coningsby was switched to No. 11 Group (from No. 38) control in October 1974, signifying the beginning of the switch, and the base remained the centre of Phantom operations until the F-4 was ousted by the first Tornado F.Mk 2/3s in the late 1980s. Wattisham was established as the second Southern QRA(I) base, while Leuchars was reinforced by the dispatch northwards of No. 111 Squadron. The latter unit was initially equipped with FGR.Mk 2s, but later transitioned to the FG.Mk 1 to provide commonality with the co-located No. 43 Squadron. The dwindling Lightning force concentrated at Binbrook as it was displaced by Phantoms. Similarly, as the Tornado F.Mk 3 entered service, the Phantom force contracted to two squadrons at Wattisham.

No. 29 Squadron (above) was the second of the 'new' Phantom air defence units, established at Coningsby. No. 23 (below), like other squadrons, formed at Coningsby before moving on to a new home, in its case Wattisham.

The RAF camouflage on this No. 43 Sqn FG.Mk 1 is beginning to wear thin, showing the old No. 892 Squadron/Royal Navy scheme underneath.

No. 23's red eagle badge was presented on the nose while it was a UK AD unit, but was moved to the fin when it served in the Falklands. The UK fin-band was blue/red.

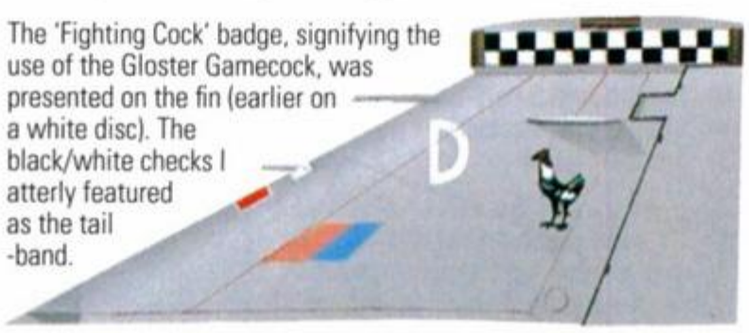
No. 23 Squadron

Base: RAF Coningsby, RAF Wattisham from 25 February 1976
Designate squadron formed: 6 October 1975
Official formation: 17 November 1975
Declared operational: 14 May 1976
Disbanded: 31 March 1983 (reformed next day at RAF Stanley, Falkland Islands)

The No. 29 Squadron badge of an eagle preying on a buzzard was worn on the nose for many years, but was later moved to the fin to join the three-X tailband.

No. 29 Squadron

Base: RAF Coningsby (PhanDet at RAF Stanley 17 October 1982 to 31 March 1983)
Designate squadron formed: 1 October 1974
Official formation: 1 January 1975
NATO stand-down: 1 December 1986
Disbanded: 31 March 1987



The 'Fighting Cock' badge, signifying the use of the Gloster Gamecock, was presented on the fin (earlier on a white disc). The black/white checks l atterly featured as the tail -band.

No. 43 Squadron

Base: RAF Leuchars
Start of operations: July 1969
Official formation: 1 September 1969
Declared operational: 1 July 1970
NATO stand-down: 1 July 1989
Phantoms withdrawn: 31 July 1989

UKADR deployment these consisted of: Northern – Nos 43 and 111 Sqns at Leuchars; Central – Nos 29 and 64 (OCU) Sqns at Coningsby, augmented by two Lightning squadrons at Binbrook on short-range air defence; and Southern – Nos 23 and 56 Squadrons at Wattisham. By far the busiest of the regions was the Northern, No. 111 Squadron recording 100 intercepts in one week during April 1980. Most of the 'Zombies' were 3M/M-4 'Bisons', Il-38 'Mays', Tu-16 'Badgers' and Tu-95/142 'Bears' snooping round NATO activities in the GIUK (Greenland-Iceland-UK) Gap, out through which the Soviet Northern Fleet was expected to break in time of war. The Southern IAF had the role of backing up the Northern units in periods of intense operations, in addition to standing 'Q' in its own region. It was not until 26 January 1978 that Wattisham undertook its own first scrambled intercept of a Soviet patroller.

Aircraft on Northern 'Q' occasionally had to land at other bases, notably in Norway or at

Northern QRA

Wing Commander Dave Wood, now OC No. 56 Squadron, remembers his time on 'Treble One', flying the Phantom on alert duties.

"You would be on QRA about once every 10 days or so. We took over at 8 o'clock in the morning, first checking the telebrief to bring yourself up to speed with what was happening. This was a secure line between Buchan and Leuchars which beeped every 15 seconds just to let you know it was working. The jets were usually in the 'Delta' fit – three tanks, four Sparrow or SkyFlash, and four 'Winders.

"There was normally plenty of time to get ready for the scramble, as most of the trade was handed on by the Norwegians or the USAF on Iceland. If it looked like they were coming into the UKADR, the Q1 jet was launched unsupported. If they didn't turn back, which they often did, Q2 was launched with tanker support. You could get up to seven hours airborne in Q2, following the intruders around until they departed the area. After the first launch, Q3, which was at 60-minute readiness, would be called in. As each Q aircraft was launched, another was brought up to readiness. During exercises it could get really busy, and once I launched as Q13! There was not enough time to fit more than a couple of Sidewinders to the aircraft, not even tanks. Wherever you looked that day there were aircraft, and we only had Shackleton AEW cover then.

"In the daytime the mission was straightforward, and there was time for a little play with the 'Bears'. As far as the Soviets went this got a little out of hand, for they started putting a KGB officer onboard to stop the crew waving to us. Some 'Bear' variants had a crawlway between the front and back compartments – a long and uncomfortable journey which involved clambering over unprotected wing spars and other obstructions. We soon worked out that by moving our jet forwards and backwards we could get this poor idiot to spend hours crawling back and forth down this tunnel, just to stop the crew from waving at us.

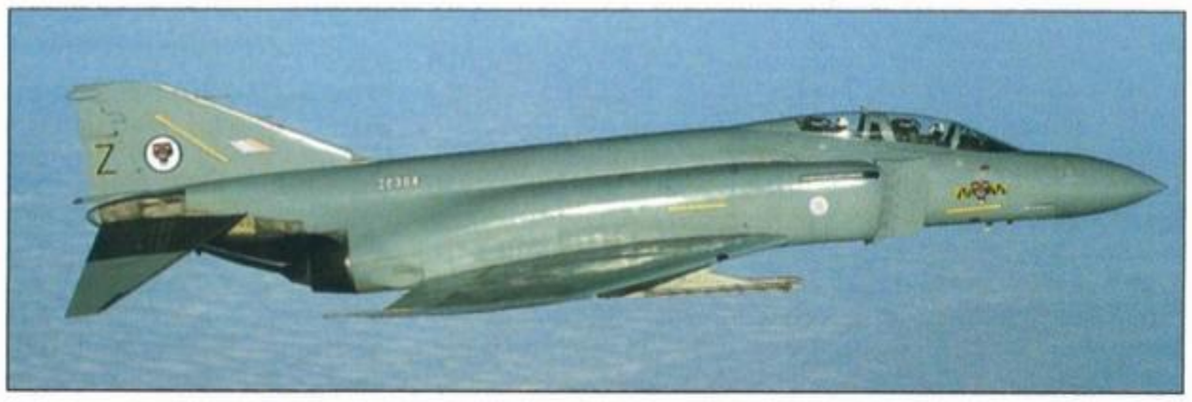
"Intercepts were usually controlled, and we aimed for a stern conversion. The tail guns of the 'Bears' usually lit up the RWR and the continuous wave [lock-on] warning, which was a bit disconcerting. When there were two aircraft, we were supposed to go to the aft one first, check it out and then move to the front aircraft. In practice, though, we usually intercepted the front one first as it was then more fuel-efficient to drop back to the trailing aircraft.

Above: A No. 56 Squadron Phantom in 'Delta' fit is seen in the Q-shed, ready to scramble.

Left: Victor K.Mk 2s provided most of the tanker support for the interceptors, but other types were also used. These included Vulcan K.Mk 2s, drogue-equipped KC-135s, Hercules C.Mk 1Ks and even buddy pod-equipped Buccaneers

Above: As first established, No. 111 Sqn was an FGR.Mk 2 operator (illustrated). It converted to FG.Mk 1s between 1978 and 1980 as ex-Royal Navy machines became available.

In later years No. 56 Squadron adopted all-red tails (above), flying alongside the black-tailed aircraft of No. 74 Squadron. The latter unit reformed to operate the F-4J(UK) aircraft (right), nine of the 15 being delivered with this strange bluish scheme.



The Phoenix badge of No. 56 was usually worn on the nose, but in the late 1970s appeared on the tail. Red/white checks moved from the intakes to the fin on the addition of RWR.

No. 56 Squadron

Base: RAF Coningsby, RAF Wattisham after 8 July 1976
Designate squadron formed: 22 March 1976
Official formation: 29 June 1976
Declared operational: 13 September 1976
NATO stand-down: 30 June 1992
Disbanded: 1 July 1992

As the only F-4J(UK) operator, No. 74 Squadron did not have the RWR fairing for a fin-band. Tail markings consisted of the unit's tiger badge.

No. 74 Squadron

Base: RAF Wattisham
Official formation: 1 July 1984
Declared operational: 19 October 1984
First FGR.Mk 2 operations: 15 January 1991
NATO stand-down: 30 September 1992
Disbanded: 1 October 1992

No. 111's complicated badge consisted of red crossed swords (for London), Palestine cross and three seaxes (for Essex). The badge was repeated on the nose with a lightning flash.

No. 111 Squadron

Base: RAF Coningsby, RAF Leuchars from 3 November 1975
Designate squadron formed: 1 July 1974
Official formation: 1 October 1974
NATO stand-down: 30 September 1992
Disbanded: 1 October 1992

Keflavik. Quickly refuelled by the local ground crew, the aircraft resumed their alert posture at the new location until scrambled again or their 24-hour alert period was over, whereupon they transited back to Leuchars. Tankers were regularly scrambled to provide support on long-range intercepts or long-endurance shadowing flights. The 'Zombies' which headed out across the Atlantic were often handed over to the USAF's interceptors from the 57th FIS, based in Iceland.

Recognition of the importance of the Phantom as an interceptor came in a series of updates in the mid-1970s. From 1975 Marconi ARI 18228 radar warning receivers sprouted in rectangular fairings from the fin-tip, while in 1978 (beginning with XV474) the tactical grey-green camouflage gave way to a new air defence scheme of medium sea grey inner wing panels, Barley (or 'mixed') grey fuselage and outer wings, and light aircraft grey undersides. Toned-down national insignia followed soon after. More importantly, in 1979 the elderly AIM-7E-2 Sparrow missile was replaced in the

'Treble One' transitioned from the FGR.Mk 2 to the FG.Mk 1 (illustrated), which lacked INAS. Although this made scrambles quicker, it could pose navigation problems when operating for long periods over water.

"High-level intercepts were OK, but at low level the 'Bears' gave us a hard time. With three bags onboard the Phantom was hard work at low level, especially when the 'Bears' were turning hard, trying to shake us out of the sky. A common ploy was for them to descend very slowly, trying to fly us into the sea.

"When the Russians were dropping sonobuoys we had to record the pattern, and occasionally we also worked with Nimrods. We took pictures of everything, including the buoys actually in their bays, and eventually we even got colour film and decent cameras. The intelligence guys loved us for what we brought back, although there was a certain amount of gamesmanship going on. The Soviets were always bolting on some extra 'aerial', or painting on a panel just to get the 'int' guys going. Once I was flying an aircraft with an all-white drop tank. I can't remember why it was so, but it certainly got this 'Bear' crew most excited.

"Once in a while we would perform a silent scramble, launching with no comms and no radar. We would maintain this until a certain point and then go active. This ensured an intercept occurred, and didn't give them any warning that we were coming which would give them time to turn back. There were a lot of 'fishing vessels' out in the northern seas in those days, listening to all of NATO's comms. We often looked at them, too.

"At night the mission was different – deadly serious. They always had their lights out, and we often used the moon to identify them, trying to silhouette them to allow a positive identification. One night I was scrambled against a pair of what the Norwegians had identified as 'Badgers'. In fact, they were 'Bisons', a B and a C. I was just checking out the front guy when all of a sudden some sixth sense told me that all was not right. Maybe there were just fewer stars than there ought to be. I looked away from the 'Bison', off to port, just in time to see his wingman banking in straight towards us from starboard. If I hadn't moved he would have hit us.

"On another occasion we went off after a couple of 'Bears', thinking that we had a free run at them. Suddenly we found ourselves just missing a pair of USAF Phantoms which had been shadowing them, unknown to us. The Americans had been there with lights off and close enough to the 'Bears' that their small radar returns could not be broken out from the huge return of the Soviet aircraft. Night-time intercepts were no fun.

"During the early 1980s the Soviets restructured their long-range fleet, and it was our job to individually identify the aircraft. The only positive i.d. was the number on the nosewheel door, so we had to get in really close. At night it could get very hairy, and we had no NVGs. The best way was to get in close underneath and then slam on the afterburners to light up the underside. Occasionally they would drop flares, which was not a pleasant experience.

"I served on 'Treble One' from 1980 to 1984 – the best era for intercepts – and in the end I had 52: 'Bears', 'Badgers', 'Bisons', 'Coots', even 'Forgers' from when they moved the *Kiev* from the Black Sea to the Northern Fleet. I felt as if I was doing a real job – that it meant something. It was our country, and you could see it made a difference."

Partnering 'Treble One' at Leuchars was No. 43 Squadron. Here a Tu-95RT 'Bear-D' receives attention from one of the unit's FG.Mk 1s. 'Bear-Ds' often flew patterns while communicating with Soviet ships and other aircraft.

Battle Flight

In Germany, the air defence mission was very different from the long-range overwater intercepts practised by UK AD crews. Then-Flying Officer Ian Black of No. 19 Squadron, recalls the task.

"Everything was green, drab olive green; it seemed that if it moved, it had to be painted green. Perhaps some civil servant had ordered a job lot of paint where the only choice of colour was green. The RAF had enjoyed its most colourful period from 1950-1975 – silver fighters with coloured tails, gloss camouflaged aircraft with high-vis roundels. In the 1980s, RAF Germany (2 ATAF) was definitely entering its green period. For the crews of the Germany Phantom squadrons the Cold War was at its zenith, and the awesome might of the Warsaw Pact war machine was being kept at bay by the front-line forces of 2 ATAF. Principal players were the Harrier GR.Mk 3s, the Phantom FGR.Mk 2s and the nuke-equipped Buccaneers and Jaguars. NBC (Nuclear, Biological, Chemical) was a daily word for those who lived on the edge. The ability to fight and survive a chemical attack was the ultimate goal of the two Wildenrath Phantom squadrons. Close to the Dutch border, Wildenrath had been home to the Harrier but now the Phantom ruled the circuit.

"Replacing the Lightnings of 19 and 92 Squadron (the 'Blue Dolphins' and the 'Cobras'), the F-4Ms had already been in-theatre a number of years before in the strike attack/reconnaissance role, before taking up the vastly different role of low-level air defence. Machines that had been pounded in the harsh low-altitude strike role were given a new lease of life as air defenders. In reality, the role was even more punishing than that of the 'mud movers', for now the Phantoms were constantly turning and burning in the low-level airspace, looking for prey.

"Armed with four radar-guided Sparrow missiles (later SkyFlash) and four Sidewinder AIM-9G/Ls, and the underslung Gatling gun, the FGR.Mk 2s ruled the skies above central Germany. With its powerful AWG-12 radar, the FGR.Mk 2 was ideally suited to the low-level world of 2 ATAF SOPs. Standard operating procedures: take fully-armed Phantoms up to a low CAP near the border, waiting for trade. Initially, the threat was East German MiG-21s and Su-22 'Fishbeds' and 'Fitters'. Soon this changed to the MiG-23 'Flogger', both in the ground attack version and the air defence variant. The FGR.Mk 2 with its mighty arsenal could have easily dispatched whatever the Warsaw Pact threw up at us.

"The Germany crews were supremely confident in their machines and tactics. Most had a wealth of air defence experience, either from the UK or from the Lightning at Gütersloh. Some had even flown with the Navy on the *Ark*'s last cruise. The main role for the Wildenrath wing was to plug the gap in the Hawk/Nike SAM belt. Despite operating at high speed and low level, the FGR.Mk 2's radar could still pick up targets at 25 miles plus. This was only bettered when the awesome Eagle arrived at Bitburg and Soesterberg. Despite its head-on capability, the preferred attack profile was still the stern conversion – this was in the days before IFF interrogators and AWACS to tell you if the target was friendly or not. An accurate i.d. from the crew was vital to avoid a 'blue on blue'. That said, 92 Squadron Phantom XV422 did score a spectacular 'blue on blue' when it accidentally shot down a Jaguar with a live Sidewinder. Luckily, the pilot ejected safely, but it illustrates the high level of operational flying that took place.

The SUU-23/A cannon pod was a regular fit for the low-level Phantoms in Germany. Sparrow/SkyFlash acquisition rounds were carried in the forward bays to maintain cg limits.

"The Wildenrath wing was considered to be the best among the RAF's Phantom force; they were, after all, the first line of defence. For the front-seater, flying the Phantom in Germany was a great experience as it was simply a case of 'tapping' any fighter he saw while cruising at low level – they were carefree days. For the back-seater, it was a hard and unpleasant environment, stuck in the 'coal hole', most of your life spent with your head in the cockpit staring at the radar scope. All this while your pilot thrashed around at low level pulling 4-5 *g*. Definitely the place for those keen to increase their collection of airline sick bags! Navigators developed a sixth sense of situational awareness, knowing where they were without looking out. Surprisingly, while operating in this severe environment, accidents were few, though they were usually fatal.

"Flying the Phantom in Germany was one of the most exciting jobs ever for an air defender, the likes of which crews are unlikely to see in the future. Unrestricted airspace, few rules and a potent fighter – what more could we have asked for?"

The forward-facing strike camera was only rarely fitted to air defence Phantoms, but its presence here can be explained by the single live SkyFlash missile carried by this No. 19 Squadron aircraft: it is seen during a Missile Practice Camp (MPC) sortie from Valley.

The pulse-Doppler radar gave the Phantom an unmatched low-level air-to-air capability in the early days, allowing it to rule the roost until the arrival of the 'teen-series' fighters. Even then, the RAF crews gave the F-15 and F-16 pilots a hard time until they learned to fully operate their new mounts.

front line by the BAe SkyFlash. Originally developed as the Hawker Siddeley Dynamics XJ521, the SkyFlash looked identical to the missile it replaced, but inside was a new monopulse Marconi seeker, EMI radar proximity fuse and other improvements which made the weapon far more capable, especially in its resistance to ECM. In the early 1980s the tail-chase AIM-9G Sidewinder was replaced by the all-aspect AIM-9L.

Other developments among the AD squadrons brought the re-equipment of No. 111 Squadron with the FG.Mk 1 from 1978. This was made possible by the retirement of the Navy's Phantom force, which was gradually passed over to the RAF. Several FG.Mk 1s were put into storage and were used in subsequent years to even out wear and tear across the fleet. Most were finally provided with the ability to carry the centreline cannon pod. No. 111's displaced FGR.Mk 2s provided a welcome influx of airframes for the other squadrons. On 1 January 1980, No. 29 Squadron at Coningsby was redeclared from SACEUR to SACLANT, joining No. 43 in the TASMO role. The UK-based Phantom force and its operations then remained relatively stable until events in the South Atlantic upset the applecart, creating another reshuffle of aircraft and units.

A No. 19 Squadron Phantom blasts off from Wildenrath. The FGR.Mk 2 usually took slightly longer to get airborne on a scramble than the FG.Mk 1 as its inertial navigation system had to be aligned for navigation purposes. The ex-Navy variant had a 'steam-driven' nav computer, and could be got airborne just as quickly as the engines could be fired-up.

RAFG air defence

Once the UK AD squadrons had been re-equipped with Phantoms, the turn came of RAF Germany's two AD units, Nos 19 and 92

RAFG AD units

With the UKADR squadrons fully equipped with the Phantom, attentions turned to the two RAF Germany fighter units, operating the Lightning F.Mk 2A. The Lightnings had been based well forward at Gütersloh, but the Phantoms were based back near the Dutch border at the 'clutch' airfield at Wildenrath. In the immediate post-Cold War era, the reunification of Germany robbed the RAFG Phantom squadrons of their primary role, and they were duly disbanded in the second half of 1991.

Nos 19 (left) and 92 (above) Squadrons were paired up to operate Lightnings in Germany, and both adopted the Phantoms within months of each other.

No. 19 adopted the dolphin as its badge to signify the Sopwith fighter of the same name. The blue/white checks were worn on the tin-tip or intakes

No. 92 was an East India 'gift' squadron in World War II, hence the significance of the cobra. The maple leaves signified its origins in World War I as a Canadian unit.

No. 19 Squadron
Base: RAF Wildenrath
Designate squadron formed: 1 October 1976
Official formation: 1 January 1977
NATO stand-down: 31 December 1991
Disbanded: 9 January 1992

No. 92 Squadron
Base: RAF Wildenrath
Designate squadron formed: 1 January 1977
Official formation: 1 April 1977
NATO stand-down: 30 June 1991
Disbanded: 5 July 1991

The Spey was very powerful at low altitude, but ran out of 'grunt' at high altitude compared to the J79 which powered non-UK Phantoms. This was less of a problem for the RAFG units, which plied most of their trade at low level.

Squadrons. Assigned to 2 ATAF, the two units provided air defence for the whole of northern West Germany and an area of the North Sea out to the boundary with the UKADR. Conversion of these units was considered less pressing than in the UKADR, as the Lightning was still effective in the short-range, low-level environment prevalent in the RAFG mission. Whereas UKADR Phantoms routinely flew long distances to intercept bomber-sized targets at high altitudes, the threat in 2 ATAF was principally from fast, low-level strike aircraft coming across the East German border. Besides, the 2 ATAF interceptor units were tasked with operations below the Nike missile belt, restricting their operational altitude.

Nevertheless, the Phantom's excellent radar and eight (as opposed to two) missiles represented a welcome increase in capability, although the Phantom was not as comfortable to fly on the low-level 'hot-cold' CAPs (which employed a racetrack pattern so that one aircraft always had its radar facing 'up-threat'). The Phantom's superior range allowed the squadrons to be brought back farther from the border to within the 'clutch' of airfields near the Netherlands, reducing vulnerability to surprise attack but increasing the flying time to the East German border. The defence of these bases, with their nuclear strike aircraft, was an important part of the Phantom's tasking. The main role, however, was to provide a five-minute QRA(I) alert, dubbed Battle Flight, and to patrol the ADIZ (Air Defence Identification Zone), a buffer of airspace running along the border. Any unidentified aircraft entering the ADIZ required an immediate launch by two Phantoms for identification and, if necessary, intervention.

Operating from hardened aircraft shelters and flying air defence grey aircraft from 1978 onwards, the RAFG AD units were on constant alert and would have very likely been the first NATO aircraft into action should Warsaw Pact forces have ever launched an attack. This very serious mission lasted until Germany was reunited, the two squadrons disbanding shortly after. On 25 May 1982 a No. 92 Squadron aircraft, XV422, claimed the dubious distinction of being the only RAF Phantom to score a kill, when an inadvertent firing of an AIM-9 during some *ad hoc* air combat caused the loss of a No. 14 Squadron Jaguar (XX963). Mercifully, the Jaguar pilot ejected successfully.

Falklands

Although the Phantom was to become well acquainted with the Falkland Islands, it played only a secondary part in Operation Corporate, the retaking of the islands from the Argentines. In April 1982 No. 29 Squadron received notification that it was to provide a three-aircraft detachment at the vital staging post on Ascension Island, just south of the Equator and roughly half-way from the UK to the Falklands.

On 24/26 May the aircraft left Coningsby and arrived at Wideawake Airfield after a 9½-hour flight. The following day the Phantoms relieved No. 1 Squadron Harriers which had hitherto been standing an air defence alert. Between then and 14 July, the detachment of five crews maintained a 24-hour QRA to protect the base and the shipping lanes in the vicinity. The detachment was scrambled on several occasions to investigate both air and surface targets, the most memorable being the intercept on 11 July of two Soviet Tu-142 'Bears' which were snooping around returning elements of the Task Force. On 18/19/20 July the three aircraft returned to Coningsby.

However, the Phantom would not be away

RAF Phantoms fought with just about everything, but regular 'trade' was provided by No. 100 Squadron's target facilities Canberras, including target-towing for APCs by TT.Mk 18s.

Above: From 1980 No. 29 Squadron was assigned to SACLANT in the maritime air defence role. The unit was deployed to Ascension two years later to provide air cover for the base during the Falklands conflict.

Below: One of 15 ex-US Navy F-4J(UK)s acquired in the aftermath of the Falklands War displays the centreline cannon pod. The aircraft received a belated 'anglicisation' upgrade shortly before their retirement.

for long, for it was obvious in the post-conflict weeks that an effective air defence umbrella would have to be maintained over the islands. While Sea Harriers and RAF Harriers (hastily fitted with Sidewinders) proved ideal in the short term, a longer-lasting solution was required and the Phantom was the only realistic answer. Port Stanley had the only hard runway in the islands, but this measured just 4,100 ft (1250 m) in length, insufficient for F-4 operations. Accordingly, AM2 temporary runway matting was acquired to provide an additional 2,000 ft (610 m) of runway, while RHAG cable arrester equipment was installed at either end, cutting the landing run to as little as 700 ft (213 m) in some circumstances.

No. 29 Squadron was again chosen to provide the Falklands aircraft, and nine Phantoms began assembling at Ascension in mid-September 1982. By the middle of the following month the runway extension had been completed, and the first aircraft, crewed by Wing Commander Ian MacFadyen and Squadron Leader Pete Simpson, made the 8-hour 45-minute flight to Stanley, with seven refuellings en route, on 17 October. It was escorted in by two Sea Harriers of No. 809 Squadron. The remaining eight aircraft arrived over the following week to complete the Phantom Detachment (PhanDet). On 23 October the Sea Harrier alert stood down, 809 Squadron boarding HMS *Illustrious* for the return home. The RAF Harriers of the HarDet returned to their normal ground attack duties.

While most of No. 29 Squadron was in the Falklands, the squadron remained officially based at Coningsby, but little was seen of it back in the UK until late 1983, when No. 23 Squadron was officially tasked with the manning of the PhanDet. The aircraft themselves remained in the islands, and No. 29 Squadron recommenced its UKADR work with 'new' aircraft. No. 23 Squadron continued to fly the Phantoms from Stanley until 1985, when the official opening of RAF Mount Pleasant allowed the Phantom squadron to enjoy the luxury of a full-length runway, and purpose-built QRA 'houseys' and maintenance facilities. The Falkland Islands Air Defence Ground Environment (FIADGE) was also established, with a combat reporting centre and main radar constructed on Mount Kent, with outlying radar stations on Byron Heights and Mount Alice.

Although the threat from Argentina receded, the detachment was kept busy with forays by Argentine reconnaissance aircraft keen on monitoring the British defences. The number of Phantoms was slowly reduced to four, while the detachment was renumbered as 1435 Flight in 1988. By that time it had long ceased to be a permanent squadron assignment, and had for some months been manned on a short-duration

Island Defender

For 10 years one of the most important operational tasks for the RAF Phantom fleet was defending the Falklands. Then-Flying Officer Guy Bancroft-Wilson describes the job.

"In 1983, a four-month detachment to the Falkland Islands was not regarded too favourably by the F-4 crews of UK and Germany. However, the reality of it was that it consisted of some excellent flying and training in extremely unrestricted airspace. I arrived on 27 March, the day British Summer Time and South Atlantic Winter time began. After 11 hours in an RAF VC10 (in-flight entertainment had kindly been removed), with a one-hour refuelling stop in Dakar, we spent nine hours on the ground in Ascension. Then followed an uncomfortable 12½ hours on para seats in a packed Hercules, arriving at Port Stanley to be met by the outgoing crew of PhanDet (Phantom Detachment, which became 23 Squadron a month later).

"The accommodation left much to be desired, although the 'Coastel' – a floating hotel – had recently arrived and was to be our home every other night for the next four months. The Coastel was actually quite

Proudly wearing the Falklands crest on its nose, a No. 23 Squadron jet blasts off from RAF Stanley. Falklands-based Phantoms routinely flew with the SUU-23/A cannon pod fitted.

Test aircraft

Naturally, the Phantom was thoroughly tested by the A&AEE before it entered service: the FG.Mk 1 evaluation was handled by 'C' Squadron, the Royal Navy test unit, while the FGR.Mk 2 was wrung out by 'A' Squadron. Subsequently, the first production FG.Mk 1, XT597, remained on A&AEE charge, being used as a high-speed testbed for numerous programmes. It had interchangeable noses, one of which held equipment which allowed the accurate calibration of other aircraft's flight instruments.

For many years the A&AEE Phantom remained in Navy colours, but latterly adopted the MoD(PE) 'raspberry ripple' scheme. It is seen at right during trials of the TriStar hose/drogue system.

With the imposing silhouettes of Tumbledown (left), Two Sisters (centre) and Mount Kent (right) in the background, a cannon-armed Phantom catches the RHAG cable at Port Stanley, as well as streaming its brake chute. Three sets of Rotary Hydraulic Arrester Gear were installed on the runway.

civilised, with a well-frequented Officer's Mess bar and restaurant, and a bunk in each small room which we shared with a squadron member on the opposite shift.

"The alternate nights were spent on a 10-minute Quick Responsive Action (QRA) in three Portacabins, next to the aircraft and temporary hangars. One was the Operations room and offices, one a crewroom and the third for sleeping. There were 10 Phantom crews, with a minimum of four crews on QRA, four flying day-to-day missions, and one ops officer. This meant that we worked about 36 hours on, 12 hours off and had one day off every 10. This wasn't as bad as it sounds because generally we preferred to work, as the activities during a day off were quite limited. On average, Q1 was scrambled once a month for a perceived, suspected or unidentified threat, and once a week for practice missions.

"Our role was Falkland Islands Air Defence and, to help us achieve that, a Falkland Islands Protection Zone (FIPZ) was established for a radius of 200 miles around the islands. The F-4 was an excellent aircraft for the role because of its speed and capability as a weapons platform. All the F-4s in the South Atlantic were armed with four AIM-9L Sidewinders, four SkyFlash missiles and the ADEN cannon. This gun fired at a rate of 100 rounds a second and carried 1,200 rounds of tracer, ball and HE bullets. There was also a small detachment of four Harrier GR.Mk 3s which were used for daylight air defence and ship defence operations.

"The flying in the Falklands was outstanding. There were no towns (Port Stanley was always avoided), wires, pylons or masts, no airways, airfields or village fêtes, and very few restricted or danger areas. The only thing to watch out for were Her Majesty's ships, which were still a bit nervous seeing a high-speed potential enemy coming towards them at low level. The islands are beautiful and when the weather is good the visibility is in excess of 100 miles, and the sunsets are incredible. However, the weather, unfortunately, was inclined to be totally unpredictable, and fog would roll in at a moment's notice, hence another use for the F-4's high speed during a weather recall. The weather was somewhat interesting, as the temperature never rose above 10°C or fell below -10°C, and horizontal snow was quite common, as was 100-mph wind. During my first week in the Falklands there was no flying, due to the poor conditions.

"I flew approximately 35 sorties in 3½ months, a total of 70 hours. This included high and low practice interceptions and air combat against each other, Hercules and GR.Mk 3 Harriers. This was always popular, and very demanding for all sides. Flying a heavy Phantom against a tight-turning, slow aircraft like a Hercules or a Harrier required a certain amount of experience, determination and care. After about an hour we would need to air-to-air refuel (AAR) with the Hercules. This would take place anywhere from 20,000 ft down to 250 ft over the sea, or in the mountains, depending on convenience or the training requirement. Often AAR would be followed by a Presence Run. This was a high-level transit to the western edge of the FIPZ which would ensure the mainland would paint us on their radar to remind them of our presence. A low-level return would follow. At times the F-4s would be tasked to intercept the airbridge Hercules arriving from the Ascension Islands and escort it to Port Stanley. Also, due to our anti-shipping and ship defence role, we would practise ship attacks (for our benefit and the ships) and strafe (air-to-ground gunnery). This would be done over the land on a rocky outcrop of islands and on a splash target (something dragged by a ship to make a wave). Additionally, 15 per cent of the sorties were night flights when we had the opportunity to practise AAR and formation with night-vision goggles (NVG).

"Only two F-4s could fly at any one time due to landing restrictions at Port Stanley airfield. After the war the runway had been lengthened to approximately 6,000 ft with metal matting. Although a Phantom could land and stop in 6,000 ft, we were always heavy with a full weapons load and sufficient fuel to hold off for weather, airfield problems, scrambles or any other unforeseen problems. Therefore, every F-4 landing was into the Rotary Hydraulic Arrester Gear (RHAG). There were three on the runway: one 300 m in, one in the centre in case the hook jumped over the first, and one for an overrun. F-4 landings were arranged to be spaced by 15 minutes, which gave the fire crews plenty of time to reset the cable. Apart from the journey to and from the South Atlantic, being part of a large detachment of F-4s in the Falklands was exciting and excellent experience, but two months would have been enough."

Shortly after its ferry flight from Ascension, the first PhanDet aircraft is seen in October 1982 on the temporary matting at RAF Stanley. The runway had been completed the day before the first aircraft arrived.

cation that it was to provide a three-aircraft detachment at the vital staging post on Ascension Island, just south of the Equator and roughly half-way from the UK to the Falklands.

On 24/26 May the aircraft left Coningsby and arrived at Wideawake Airfield after a 9½-hour flight. The following day the Phantoms relieved No. 1 Squadron Harriers which had hitherto been standing an air defence alert. Between then and 14 July, the detachment of five crews maintained a 24-hour QRA to protect the base and the shipping lanes in the vicinity. The detachment was scrambled on several occasions to investigate both air and surface targets, the most memorable being the intercept on 11 July of two Soviet Tu-142 'Bears' which were snooping around returning elements of the Task Force. On 18/19/20 July the three aircraft returned to Coningsby.

However, the Phantom would not be away for long, for it was obvious in the post-conflict weeks that an effective air defence umbrella would have to be maintained over the islands. While Sea Harriers and RAF Harriers (hastily fitted with Sidewinders) proved ideal in the short term, a longer-lasting solution was required and the Phantom was the only realistic answer. Port Stanley had the only hard runway in the islands, but this measured just 4,100 ft (1250 m) in length, insufficient for F-4 operations. Accordingly, AM2 temporary runway matting was acquired to provide an additional 2,000 ft (610 m) of runway, while RHAG cable arrester equipment was installed at either end, cutting the landing run to as little as 700 ft (213 m) in some circumstances.

No. 29 Squadron was again chosen to provide the Falklands aircraft, and nine Phantoms began assembling at Ascension in mid-September 1982. By the middle of the following month the runway extension had been completed, and the first aircraft, crewed by Wing Commander Ian MacFadyen and Squadron Leader Pete Simpson, made the 8-hour 45-minute flight to Stanley, with seven refuellings en route, on 17 October. It was escorted in by two Sea Harriers of No. 809

Falklands units

In the initial aftermath of the Falklands War, air defence of the islands was provided by Royal Navy Sea Harriers, and by RAF Harrier GR.Mk 3s equipped with Sidewinder missiles. They operated from carriers, from the Port San Carlos FOB and later from RAF Stanley. To provide a more meaningful defence, the first of nine Phantom FGR.Mk 2s from No. 29 Squadron, flown by Wing Commander Ian McFadyen, landed at Stanley on 17 October 1982. No. 29 Squadron remained based at Coningsby, the Falklands detachment being known as the PhanDet. The following March, No. 23 Squadron personnel took over the detachment, which was raised to squadron status. In 1985/86 the Phantoms moved to the new airfield at Mount Pleasant. As the threat receded, the number of Phantoms on charge dwindled, stabilising at four and crewed on rotation by the UK-based squadrons. In November 1988 the unit renumbered as 1435 Flight. Tornado F.Mk 3s took over operations in July 1992.

Flanked by No. 23 Squadron's blue/red bars, the Falklands Phantoms wore the local islands crest, consisting of a ram standing on Tussac grass, above a blue/white wave pattern and a ship. The aircraft wore either a red eagle (No. 23 Squadron) or red Maltese cross (No. 1435 Flight) on the fin.

A key facet of Falklands operations was refuelling from the single drogue of the Hercules C.Mk 1K tankers of No. 1312 Flight.

The four Phantoms remained at Mount Pleasant, one being put on the gate and the remainder being scrapped.

PhanDet (No. 29 Squadron)
Base: RAF Stanley
First aircraft arrival: 17 October 1982
Disbanded: 30 March 1983

No. 23 Squadron
Base: RAF Stanley, RAF Mount Pleasant
Formed: 1 April 1983
Disbanded: 30 October 1988

No. 1435 Flight
Base: RAF Mount Pleasant
Formed: 1 November 1988
Final Phantom operations: July 1992

Special schemes

Once the Phantom reached air defence squadrons, special schemes began to proliferate. In 1979 two No. 56 Squadron aircraft were painted up for the 60th anniversary of Alcock and Brown's transatlantic crossing, one flying across the ocean crewed by Squadron Leader Alcock (nephew of the original Alcock) and Flight Lieutenant Browne.

Below: In the final months of Phantom operations both RAFG units flew all-blue aircraft. This is the No. 92 Squadron 'special'.

'Treble One' was never slow in applying special schemes to its aircraft. The black/yellow scheme first appeared on XV574 in 1985, but the black was later extended, as seen at left. Below is XV582 in the last 'Treble One' special scheme. Known as 'Black Mike', the aircraft is still at Leuchars.

Left: Perhaps the most ambitious scheme applied to an RAF Phantom was this superb tiger representation by No. 74 Squadron at the end of the F-4's RAF career. Sadly, the paint job never made it into the air, as the aircraft had already been grounded.

Right: The A&AEE's FG.Mk 1 was marked for the Phantom's 25th anniversary in 1983, with roundels representing all of the user nations. It was a major attraction at that year's International Air Tattoo, which staged a Phantom 25th meet.

Belatedly, the F-4J(UK)s were extensively refurbished with greater UK content, including ejection seats scavenged from retired FG.Mk 1s, allowing a return to British flying equipment. Even the strange paint scheme gave way to standard RAF colours. Despite a considerable amount of money being spent on them, the aircraft were retired in January 1991 immediately following the disbandment of 228 OCU, which released a supply of low-time FGR.Mk 2s. Many mourned the passing of the J79-powered aircraft, which were better-performing in most respects than their Spey-engined brethren.

Left: In the course of inter-unit and inter-service rivalry, many unofficial (and often less than tasteful) extra markings were applied to RAF Phantoms, but few lasted less time than this swastika and Spitfire kill marking which appeared on a No. 56 Squadron aircraft. The 'Firebirds' regularly hosted a Luftwaffe exchange pilot, which may partially explain the 'joke'.

Finale

Seventy-five FGR.Mk 2s were rewinged by British Aerospace from 1987 to extend their useful lives, but by this time the end of the Phantom's RAF career was approaching. On 1 December 1986 No. 29 Squadron stood down to prepare for conversion to the Tornado F.Mk 3, for which Coningsby was chosen as the first front-line base. Accordingly, 228 OCU moved north to Leuchars in April 1987. Here, again, it was 'chased out' by the Tornado F.Mk 3 as first the 'Fighting Cocks' of No. 43 Squadron and then the 'Tremblers' of No. 111 Squadron switched to the new fighter, a process completed in January 1990. This marked the end of the FG.Mk 1's service career. The OCU hung up its gloves later that year, the much-reduced training commitment being handed over to a flight within No. 74 Squadron. No new crews were trained, the flight existing only to 'retread' former F-4 crews returning to the aircraft.

That there was still useful work for the Phantom to do was beyond question: in August 1990 Phantoms from Nos 19 and 92 Squadrons were on APC on Akrotiri when Iraq invaded Kuwait. The aircraft immediately assumed an operational air defence posture, standing QRA to defend the strategically important Mediterranean base. In addition to their defensive duties, the Phantoms also provided tough and welcome practice opposition for the air wings of US Navy carriers heading for the war zone.

1991 saw BAe performing the last Phantom overhaul, while in the second half of the year RAF Germany said goodbye to its air defence Phantoms. They were not to be replaced, for the end of the Cold War and the reunification of Germany had removed the need for RAF interceptors. Nos 19 and 92 Squadrons, two of the RAF's most glorious fighter units, were reborn as reserve units as part of the Hawk trainer fleet.

That left Nos 56 and 74 Squadrons at Wattisham, both flying FGR.Mk 2s. At the end

Demonstrating the typical carrier-style, no-flare landing employed by the Phantom, a No. 74 Sqn FGR.Mk 2 lands at Wattisham in September 1992. This was in the last days of RAF Phantom operations, No. 74 Squadron down-declaring from NATO at the end of the month.

Above: On 11 June 1992 this 16-ship formation, staged by Nos 56 and 74 Squadrons, toured several former haunts of the Phantom, one of many 'Phan-out' occasions.

Right: Although largely outclassed by 'teen-series' fighters in its twilight years, the Phantom was still a formidable fighter. Flown and operated well, the F-4 often proved the undoing of pilots in supposedly more capable machines.

of June 1992 No. 56 stood down from its Southern QRA duties, followed by No. 74 Squadron at the end of September. The two squadrons had marked the passing of the Phantom in fine style earlier on 11 June with an immaculate 16-ship formation of black-tailed 'Tigers' and red-tailed 'Firebirds'. At the time of their retirement there were plans to store a number of aircraft in airworthy condition as a combat reserve, but the effects of ever-dwindling defence budgets and compliance with the CFE treaty put paid to the plans. A fair number do survive, however, as gate-guards, museum pieces (including No. 19 Squadron's all-blue aircraft in the Czech museum at Kbely) and battle damage repair trainers. 'Treble One' zealously guards 'Black Mike', an FG.Mk 1 in all-over gloss black paint which is dutifully wheeled out to take pride of place at squadron occasions and at the annual Leuchars air show.

Throughout its service and in any of its principal roles, the RAF found the Phantom exhibiting a toughness that endeared it to its crews. For two decades it was in the front line of the Cold War, be it shadowing 'Bears' over the grey northern oceans, waiting for the call to deliver nuclear weapons to blunt a Warsaw Pact attack, or taking on fighters at low level over the German plains. Like the Buccaneer, the Phantom was an aircraft that the RAF originally did not want, but which became one of its most prized assets. **David Donald**

Gate-guards

Once the protectors of the whole United Kingdom, several Phantoms remain in service as 'guardians' of the gates of RAF facilities, as follows: Akrotiri (XV470), Benbecula (XV467), Boulmer (XV415), Brampton (XT914), Buchan (XV581), Coningsby (XT891), Leuchars (XT864), Mount Pleasant (XV409), Neatishead (XV420), St Athan (XV500) and Woodvale (XV468). Various other airframes are in use as battle damage repair trainers, decoys or targets. Ex-RAF Phantoms on museum display are: Duxford (XV474 and ZE359 – as an F-4J), Hendon (XV424) and Kbely (XT899).

RAF Coningsby is home to XT891 (above), the first FGR.Mk 2 delivered to the RAF. Shown below is the ex-1435 Flight aircraft which remains on guard at Mount Pleasant, Falkland Islands.

Above: Three gate-guards – from top to bottom are XV500 (St Athan), XV467 (Benbecula) and XV422 (Stornoway). The latter, infamous for being involved in the inadvertent shoot-down of a Jaguar, was scrapped in late 1998 after the closure of the Hebridean RAF outpost.

"Niet praten maar doen" ("Actions, not words")

As the oldest operational squadron in the Royal Netherlands Air Force (Koninklijke Luchtmacht), No. 322 Squadron has a long and colourful history stretching back as far as the early years of World War II when it was formed as the RAF's first all-Dutch squadron. After seeing action in Europe, No. 322 Squadron reformed as a unit within the rebuilt Dutch air force and soon found itself in the Dutch East Indies and later New Guinea. More recently, from bases in Italy, the unit has made a major contribution to NATO's efforts regarding the former Yugoslavia.

No. 322 Squadron, Royal Netherlands Air Force

Top: Spitfires played a major role in No. 322 Squadron's 50-year history. During World War II Mk Vs were its initial equipment, augmented briefly by Griffon-engined Mk XIVs and later replaced by Mk IXs and, after D-Day, Mk XVIs. With the unit's post-war reformation within the RNethAF came another batch of Spitfires, a mixture of Mk 9s (two of which are seen here) and T.Mk 9s.

Above: In more recent times, the Lockheed Martin (formerly General Dynamics) F-16 has equipped No. 322 Squadron. The type had benefited from a recent mid-life update (MLU), which has given it a BVR capability for the first time.

At the start of World War II the Netherlands was forced to surrender to overwhelming German forces. Many Dutch military personnel escaped to England to continue the battle against the Nazis, and hundreds were trained to become pilots, navigators, gunners and bomb-aimers, mainly in the UK, Canada and the United States.

His Royal Highness Prince Bernhard was largely responsible for arranging the training of Dutch personnel at flying training schools in the UK. Prince Bernhard himself received his first flying lesson with No. 1 Elementary Flying Training School at Hatfield on 23 September 1940 in a Tiger Moth, and his wings on 9 May 1941. The prince became the driving force behind the formation of an all-Dutch squadron within the RAF, and in March 1942 a proposal was made to the Air Ministry to create a Dutch flight within a British squadron. This subsequently grew into an all-Dutch squadron as more pilots and technicians became available.

No. 167 'Gold Coast' Squadron at Castletown in Scotland was selected; the squadron had originally been raised in 1918 and after a period of deactivation was reformed in April 1942. In July the first Dutch pilots arrived at the squadron – Honert (a flight commander), Aalpoel, Geesink, Heukensfeldt-Jansen, Lutz, Mussert, Plesman, van Arkel and van

Right: The original names given to No. 322 Sqn's Spitfire Mk Vs were applied in this stencilled style; upon renaming, a different style was adopted (below right), though the Dutch orange triangle marking was retained.

Far right: F/O Frans van Eijk poses with Spitfire Mk VB BM354/'VL-A' at Llanbedr in 1943. Initially, No. 322 Sqn's aircraft carried the codes originally allocated to No. 167 Sqn, the latter having been disbanded to form the Dutch unit.

Eendenburg. Some of these pilots were taken from squadrons based in the southeast of England – against their wishes, for it was the fighter units in the southeast that were seeing the most action.

No. 167 Squadron was tasked with air defence around the Royal Navy base at Scapa Flow, the protection of convoys and reconnaissance. For these roles, the squadron was equipped with Spitfire Mk VBs. It was here that Prince Bernhard visited the squadron in September 1942 in his personal Spitfire Mk IIA (P7981). On the day in question Prince Bernhard managed a safe landing in a heavy storm, but as he taxied the aircraft it was tipped on its nose by a strong gust of wind. In accordance with squadron rules, the prince paid the customary £1 to the 'prangbox'.

The Prince Bernhard Fund, established in August 1940 to raise money in the Dutch East Indies to help provide the RAF with new aircraft, was such a success that Dutch ex-patriots from all over the world donated enough money towards a total of 100 Spitfires (Mks IIB and VB). These aircraft were named by their 'donors' and served with several RAF units; two joined No. 167 Squadron – BL664 *Tegal* and BL720 *Gedeh*.

'Rhubarbs' and escorts

In October, No. 167 Squadron moved to Ludham in East Anglia, whence the squadron began flying fighter sweeps, bomber escorts and 'Rhubarbs' – nuisance raids over enemy territory, including the Netherlands. During a shipping reconnaissance along the Dutch coast on 13 November, Pilot Officer Geesink and Flight Sergeant Norwood were attacked by a swarm of enemy fighters – Geesink shot down one Bf 109 but the Dutch pilots were greatly outnumbered, and both were shot down, picked up by a Dornier Do 18 and made PoWs.

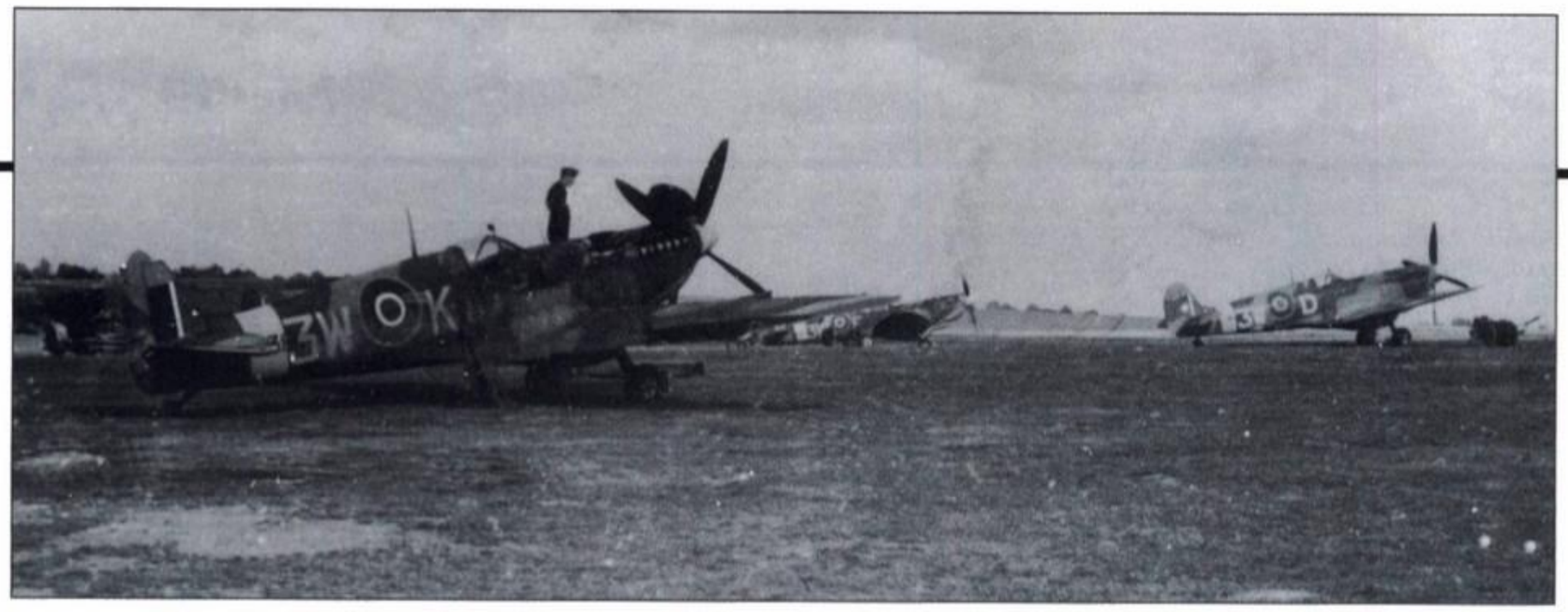
On 21 May 1943 the squadron moved to Westhampnett in southern England. Negotiations to form an all-Dutch squadron were still underway, the biggest problem being the availability of Dutch personnel. The solution as far as the ground crew were concerned was found in the Princess Irene Brigade, a Dutch Army unit in the UK. During May Army technicians from this unit were made available to the squadron.

Sixty pilots, enough to sustain the unit for a year, allowing for attrition, were also now available, so nothing stood in the way of the formation of a Dutch unit. Thus, after much work by many people, in particular Prince Bernhard, the Air Ministry gave permission for the establishment of a Dutch squadron. On 12 June 1942 No. 167 Squadron moved to Woodvale, north of Liverpool and was renumbered No. 322 (Dutch) Squadron, RAF. The squadron commander was initially a British officer, Squadron Leader A. C. Stewart, and for a while only eight of the squadron's 23 pilots were of Dutch nationality. This situation quickly changed and by September the only remaining British aircrew were the CO and one flight commander.

No. 322 (Dutch) Squadron's Spitfires initially retained No. 167 Squadron's 'VL' codes, but every aircraft carried a Dutch orange triangle marking. The squadron code was soon changed to '3W' and on 22 June HQ Fighter Command allowed the squadron to apply names to their aircraft. On 22 September, at the request of Prince Bernhard, these were applied. All were place names from the Dutch East Indies. Names allocated on 22 June 1943 were: *Ampenan, Bali, Balikpan, Bandoeng, Ban Oman, Borneo N.E.I., Celebes, Ceram, Gedeh, Lawoe, Lombok, Malang, Medan, Merapi, Molukken, Oganilil, Palembang-*

No. 322 (Dutch) Sqn's aircrew are seen here at Llanbedr during No. 12 Armament Practice Camp in November 1943.

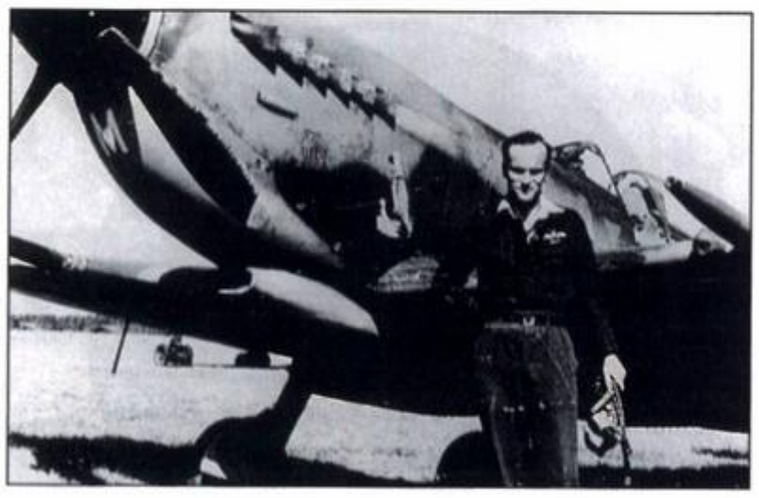
Unit Heritage



Right: Ground personnel attend to a No. 322 Sqn Spitfire Mk IX at Hartford Bridge in late 1944, before the squadron was re-equipped with Mk XVIs and moved to the continent. Note the absence of invasion stripes, removed from the upper surfaces of Allied aircraft after September 1944. At this time, the unit's main tasks were undertaking fighter sweeps and armed reconnaissances over occupied Europe.

Above: HRH Princess Juliana visited the squadron on 26 September 1944. This Spitfire Mk IXB (serialled in the MK-range and coded '3W-B') carries a squadron leader's pennant.

Below: RK840/'3W-M', a teardrop-canopied Spitfire LF.Mk XVIE, is seen here with Flt Sgt Van Roosendaal and some appropriate nose-art, featuring Polly Grey.



Left: With 'clipped' wings and with bomb racks fitted, No. 322's Spitfire LF.Mk XVIEs were optimised for ground-attack. Here '3W-J' is being run up on an unknown continental airstrip in 1945.

Below: This Spitfire Mk XVI is bombed-up for another sortie in support of ground troops, sometime in 1945. At left can be seen a discarded external fuel tank.

Oloe I, Pasoeroean, Rindjani, Sibolga, Slamat, Soekaboemi, Tarakan, Tjiandjoer, Toba. These were later replaced, on 22 September, with a new set of names honouring members of the Dutch royal family and locations in the Netherlands, as follows: *Prinses Juliana, Prinses Beatrix, Prinses Irene, Prinses Margriet, Bergen, Buiksloot, De Kooy, Eelde, Gilze-Rijen, Haamstede, Harskamp, Hilversum, Ijssel, Leeuwarden, Lek, Maas, Noordwijkerhout, Ockenburg, Rijn, Schelde, Schiphol, Soesterberg, Teuge, Texel, Twente, Valkenburg, Venlo, Vlissingen, Vught, Waal, Waalhaven, Welschap, Wieringermeer, Woensdrecht, Ypenburg.*

Obsolete aircraft

The squadron had 18 Spitfire Mk VBs at its disposal, though by this time the Mk V was obsolete. These aircraft had been modified several times to improve performance and were notable in having (in most cases) clipped wings, intended to improve roll rate at low altitudes, and Merlin engines with cropped supercharger impellers, to give maximum performance at low level. However, with tired airframes, clipped wings and low-level Merlins, the Spitfires were soon known for being 'clipped, clapped and cropped'.

The war seemed to be taking place a long way away from the unit's base at Woodvale, and although the squadron was at readiness, it saw no enemy action. Flying hours were accumulated on training flights, practising dogfights, interceptions, air-to-ground firing, formation flying and aerobatics.

It was at Woodvale that the squadron received the first of its famous parrot mascots, in July. Flying Officer N. W. Sluyter purchased the bird from London Zoo for 24 guineas. Given the rank of 'Sergeant Pilot', the parrot was a great morale booster for the squadron and it was soon suggested that Polly Grey, as it was to be named, form the centrepiece of a squadron's badge. King George VI formally gave his approval before the end of the year.

Meanwhile, in November the squadron began a spell at Llanbedr in north Wales where, at No. 12 Armament Practice Camp, air-to-air and air-to-ground firing were practised. The following month No. 322 Squadron moved to Hornchurch, the famous Battle of Britain airfield, only to find that a further move to Hawkinge was planned for 31 December.

On 4 January 1944 the squadron finally began operations, escorting a formation of 24 Mitchells of No. 320 Squadron to northern France where they bombed German rocket launch installations. A number of escort missions were flown during the squadron's time at Hawkinge, very often for Mitchells, Bostons or Marauders.

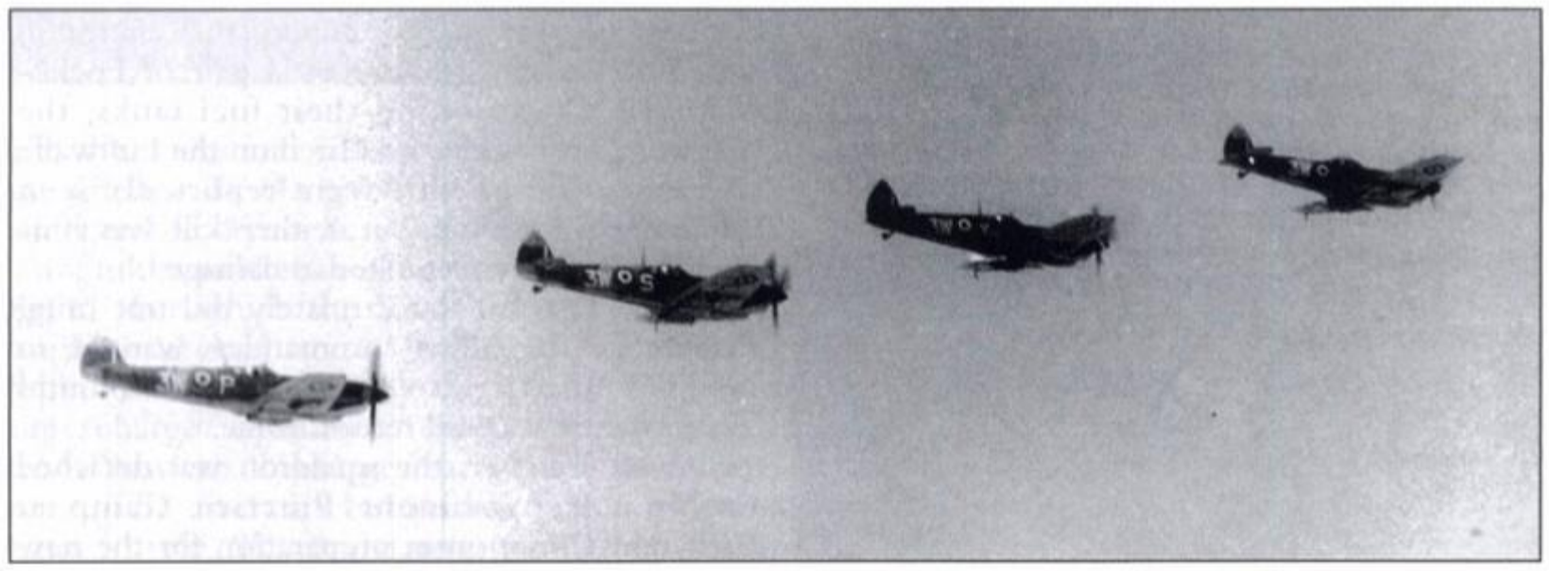
The end of February brought another Armament Practice Camp, this time No. 14 APC at Ayr, near Prestwick. Pilots were trained in dive-bombing, although their Spitfire Mk Vs lacked any sort of equipment with which to deliver bombs accurately in this way, and results were poor. From 8 March, the squadron relocated once again to Acklington, near Newcastle, where it was partly re-equipped with new Griffon-engined Spitfire Mk XIVs and given six weeks to work up on the type. On 21 April came another move, to Hartford Bridge.

With the invasion of the European mainland imminent, a new overall organisation for Allied air forces was established – the Allied Expeditionary Air Force (AEAF). The AEAF

Above: Though combat between the squadron's aircraft and Luftwaffe fighters was rare, ground fire inflicted its fair share of damage.

Left: These Spitfire Mk XVIs include aircraft of No. 322 Sqn in the foreground and No. 349 (Belgian) Sqn, seen probably towards the end of the war.

Below: This formation of No. 322 Sqn Spitfire Mk XVIs was captured on film by a No. 320 Sqn Mitchell, en route to France in February 1945. The lead aircraft, a late-production Mk XVI with a teardrop canopy, was flown by No. 322's CO, Sqn Ldr Bob van der Stok. Though its '3W' code is visible, it appears to lack an individual code letter.



was formed by the Air Defence of Great Britain (ADGB) – formerly Fighter Command – the 2nd Tactical Air Force, the US IXth Air Force and various support units. No. 322 Squadron, formerly part of No. 11 Group, Fighter Command, was now a unit within No. 141 Wing, No. 85 Group, ADGB.

Hartford Bridge airfield was shared with a French squadron flying Bostons and a British unit with Mitchells. A few days after their arrival the first missions as part of ADGB were flown, No. 322 Squadron intercepting German reconnaissance aircraft heading for the southern coast of England where large troop movements were underway in connection with the impending Operation Overlord. During April, May and June most sorties were scrambles, high-altitude defensive patrols or fighter sweeps.

D-Day taskings

On D-Day, No. 322 crews were tuned to R/T transmissions to gauge the invasion's progress and it was not until 15.15 that the squadron was called into action, undertaking an anti-reconnaissance sortie. These continued until 22.40, without incident. On the first anniversary of No. 322 (Dutch) Squadron's formation (12 June), 12 of the squadron's Spitfires escorted Dakotas towing Waco Hadrian gliders to Normandy.

On 13 June the launch of V-1 flying bombs – or 'Divers' as they were known to the RAF – began against Britain. No. 322 Squadron was one of the many units which flew anti-'Diver' sorties. They were not without danger to the pilots, as Flying Officer Jongbloed discovered when he attacked a V-1 at a height of 1,500 ft (457 m). Another aircraft fired on the V-1 simultaneously and it exploded, damaging Jongbloed's radiator so badly that he had to make an emergency landing.

A tactic often used when a pursuing aircraft was out of ammunition was to bring a wing underneath that of the flying bomb and 'tip it over', thus upsetting the V-1's gyros and causing it to crash. F/O Maier attempted this manoeuvre on 12 July, but unfortunately fell victim to a German countermeasure: the V-1 had been modified with pressure contacts on its wings, so that the wing of Maier's aircraft triggered its explosion, killing the Dutchman.

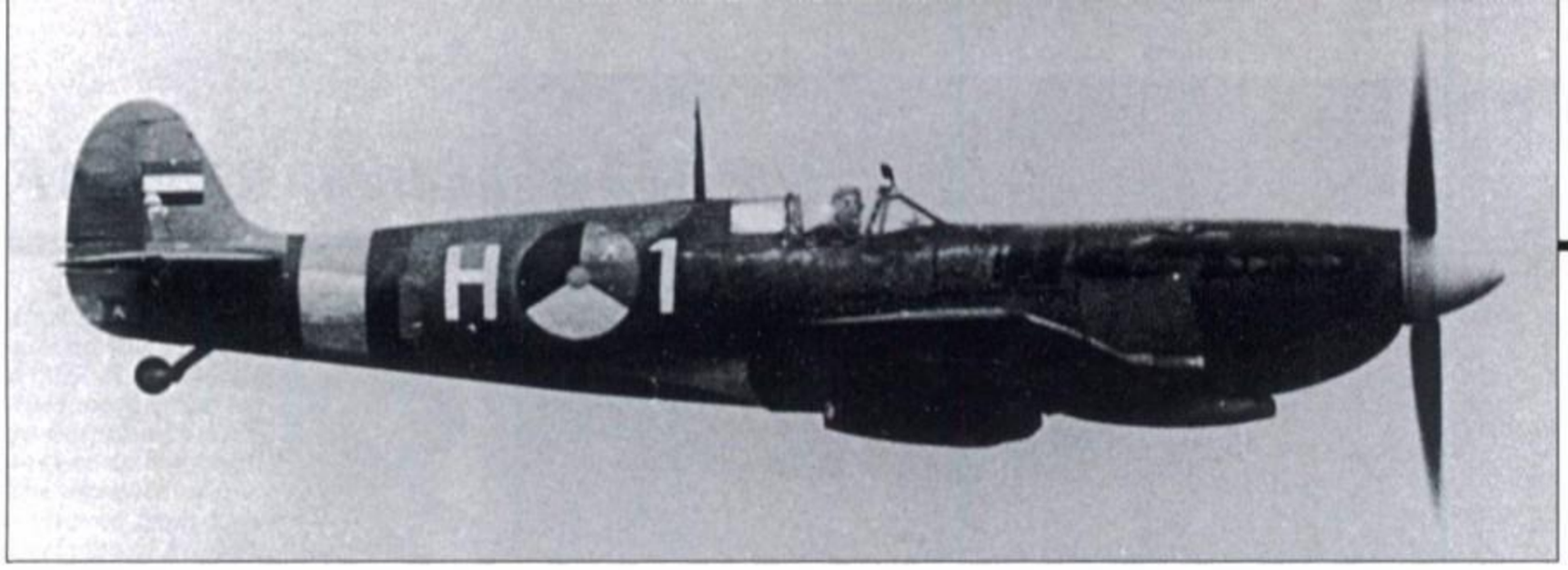
RAF West Malling, southeast of London, was the next station to host the squadron. Anti-flying bomb operations continued; a record of 62 missions was flown by the squadron on 29 June, destroying 10 flying bombs. On 21 July the unit relocated again, to Deanland, from where 'Diver' missions continued until the night of 10/11 August, when the last sortie was flown. F/O Jan Plesman shot down the squadron's last V-1, bringing the total number of official kills by the squadron to 110. The squadron unofficially claimed 128 and had within its ranks seven 'Diver' aces, with five or more kills.

Finally, in August the squadron re-equipped with Spitfire Mk IXBs which, though older, were better able to fulfil the squadron's new tasks. The battle on the continent continued and No. 322 Squadron flew 'fighter sweeps' over the Netherlands, 'Rhubarbs', 'Ramrods', escorts, convoy patrols and armed reconnaissance flights.

On 1 September 1944 the unit's CO, Squadron Leader Kuhlmann, and the two flight commanders, Flight Lieutenants Plesman and Van Eendenburg, were hit during armed reconnaissance flights. In the Operations Record Book was written:

"1-9-44: 07.05-08.35 HRS
The Squadron took part in an armed reconnaissance of the Calais-Gent-Aulnoye Area.
Claims: 4 MET [Motorised Enemy Transport], 1 light AFV [Armoured Fighting Vehicle]
Damaged: 1 MET 1 Heavy AFV
Intense accurate Flak over target area. Whilst going down to shoot up something, S/L Kuhlmann was apparently hit by Flak and he bailed out. His No. 2 however saw him land safely and wave his hands. He came down about 5 miles in land from Cape Griz Nez. S/L Kuhlmann is missing.
10.15-11.50 HRS
The Squadron again took part in an armed

Unit personnel were photographed at Varrelbusch, Germany in mid-1945. No. 322 Sqn's Spitfire Mk XVIs were based here between 30 April and 2 July.



Spitfire LF.Mk IXC H-1, the first of the KLu's Spitfires delivered post-war, was ex-RAF aircraft MJ143 and was delivered to the KLu in June 1946. During the war it had served with No. 485 Sqn, RNZAF and No. 66 Sqn, RAF before being refurbished for sale. MJ143 survives in the Militaire Luchtvaart Museum at Soesterberg.

As delivered, the squadron's post-war Spitfire Mk 9s were finished in standard RAF temperate camouflage – Ocean Grey and Dark Green upper surfaces with Medium Sea Grey undersides. This was also applied to the T.Mk 9 trainer aircraft. The KLu aircraft appear to have been both early- and late-production examples, fitted with a mixture of early and later broad-chord rudders.

reconnaissance of the same area as above. Gun post attacked and 2 MET damaged. Intense light Flak over target area. Two aircraft were hit by Flak and F/Lt Van Eendenburg was seen to make a belly landing south east of Lille. The aircraft was seen to tip up and a wing broke off, but he was not seen to get out of the aircraft. F/Lt Plesman was seen to have his tailplane shot off when he spun into the ground northeast of St Omer. He was not seen to leave his aircraft. F/Lt Van Eendenburg missing and F/Lt Plesman missing presumed killed."

Later it appeared that Kuhlmann had been taken prisoner and Plesman killed. Flight Lieutenant Van Eendenburg managed to reach Great Britain again on 12 September 1944 and subsequently was promoted to squadron commander, the unit's first Dutch leader.

D-Day for the Netherlands was set for 17 September, and No. 322 Squadron flew various fighter sweeps and escort missions during Operation Market Garden. Flying Officers Cramerus and Jongbloed were patrolling between Schouwen and Tilburg that afternoon when they were attacked by a pair of Focke-Wulf 190s. Jettisoning their fuel tanks, the Spitfire pilots engaged and fired on the Luftwaffe fighters. Both aircraft were reportedly seen going down in flames, but neither 'kill' was confirmed – both were credited as damaged.

Market Garden unfortunately did not bring the success the Allied commanders wanted, so No. 322 was forced to wait a couple of months longer before it could return home.

On 10 October, the squadron was detached to No. 18 Armament Practice Camp at Fairwood Common in preparation for the new offensive planned for early 1945. No. 322 Squadron was retrained for a task within the 2nd Tactical Air Force, providing close air support to ground troops. After the course the squadron moved to Biggin Hill on 1 November, and within a few days the squadron's 19 Spitfire Mk IXs were flown to No. 84 General Support Unit at Thruxton and new Spitfire Mk XVIs were received.

A move to a continental base – Woensdrecht near Bergen op Zoom, in the Netherlands – should have taken place on 30 December, but bad weather forced a delay of four days. No. 132 Wing was based at Woensdrecht and comprised two Norwegian, one Belgian and one Dutch squadron. From Woensdrecht, No. 322 flew armed reconnaissance sorties, fighter sweeps, close air support and bombing missions.

Meanwhile, 'Sergeant Pilot' Polly Grey was returned to London Zoo when the squadron moved to the continent. The first squadron parrot, with certainly the most Spitfire flying hours of any parrot, died at the zoo some time later.

In February 1945 Operation Veritable began, during which No. 322 provided close air support to Canadian and British troops on the ground. As more occupied territory was liberated, so the squadron moved forward, to Schijndel near Hertogenbosch on 21 February. As the war progressed further, close air support sorties were flown and losses mounted.

As the front line moved eastwards, No. 322 relocated to Twenthe for a period of only two weeks before arriving at the captured German airfield at Varrelbusch, north of Cloppenburg, on 30 April. The squadron took part in some of the last actions of the war, attacking tanks, trucks, trains and the like on 3 and 4 May, before the unconditional surrender of Nazi Germany was announced. VE-Day was set for 8 May 1945. Since its formation on 12 June 1943, the squadron had flown 4,896 operational sorties and amassed 6,382 flying hours. Eighteen pilots had lost their lives.

The squadron stayed at Varrelbusch until 2 July, when it was relocated to Wunstorf, west of Hannover, only to disband on 7 October. The squadron's Spitfires were flown back to Lasham, where most were stripped of usable parts and the hulks subsequently scrapped.

Post-war developments

After World War II, the Netherlands started rebuilding its air force and came to an agreement with the British government for the supply of aircraft. Spitfires, of course, were part of the deal and these aircraft were taken from surplus RAF stock. After an overhaul at Tilbury, test flying took place at High Ercall, Langham and Lyneham before the aircraft were flown to Pershore for repainting. Finally, from

H-60 (ex-NH238) has been fitted with bomb racks for operations in the Dutch East Indies. The 'three white mice' nose-art has its origins with 1 JaVa, a Fokker D.XXI unit that briefly fought the Luftwaffe during the invasion of the Netherlands in May 1940.

322 JaVa's base at Semarang, Dutch East Indies is the venue for this portrait of the unit's pilots and one of their aircraft. They are (standing) Rauwerdink, Noyons, Otten, Vermey, Van Gorcum; (seated) Jordaan, Nijwening, Van den Bosch (major, the squadron CO), Thijssen and Oostendorp.

Left: Ground crew pose with freshly-crated Spitfire MH725, ready to be shipped back to the Netherlands after service in the Dutch East Indies. Though KLu serial numbers were allocated, the Spitfires flew with, and apparently continued to be identified by, their ex-RAF serials.

Below and below middle: Like any other Spitfire unit, 322 JaVa had its share of landing mishaps. Here H-68 (ex-MH434) is seen after a wheels-up arrival at Kalibanteng. After service with the KLu, H-68 flew with the Belgian air force and, after a spell with target facilities contractor COGEA Nouvelle, is today a well-known warbird on the European display circuit.

June 1946 the Spitfires, serialled H-1 to H-35, were ferried to the Netherlands by No. 1 Ferry Unit, RAF.

Meanwhile, demands for independence by the Dutch East Indies were reaching their peak. Consequently, the Dutch government decided to increase the armed forces' presence in the area and on 27 September 1946, 322 Jachtvlieg Afdeling (JaVa – Fighter Aircraft Section) was established at the Jachtvliegschool (Fighter Pilot School) at Twenthe air base. The unit would operate Spitfire Mk 9s. In October it was announced that 322 JaVa would go to the Dutch East Indies to replace 120 Squadron of ML-KNIL (Militaire Luchtvaart Koninklijk Nederlands Indisch Leger = Military Aviation, Royal Netherlands Indies Army). Immediately, 322 JaVa began preparations for this new tasking in the tropics. Bombing was practised at Twenthe air base and air-to-ground firing training was carried out at the Harskamp range.

Official farewell

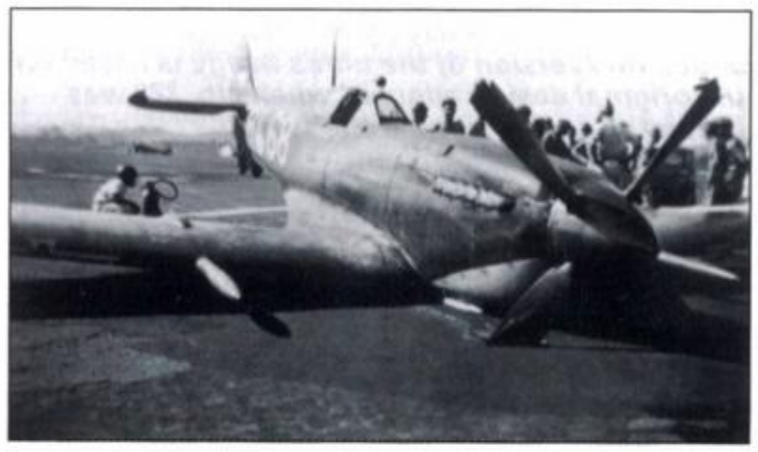
322 JaVa became 322 Squadron on 17 February 1947. After another six months of training the squadron left Rotterdam for the Far East aboard the MS *Sloterdyk*, after an official farewell at Twenthe on 9 September in the presence of HRH Prince Bernhard.

After a journey of four weeks 322 JaVa's personnel arrived in Tandjong Priok on 7 October, most pilots going on to Kemajoran to fly as co-pilots on Dakotas from No. 19 Squadron. The squadron's 20 Spitfires had arrived earlier in the Dutch East Indies. They were shipped directly from the UK in crates aboard the SS *Rotti*. From the railway station at Pasir Boengoer the Spitfires were transported, with an armed escort, by truck to Kalidjati airfield, where the aircraft were reassembled. The journey of four weeks had not done the Spitfires any good and the technicians experienced many problems, especially with instruments, wiring and propellers. Work on the first Spitfire began on 23 October, three hangars being available in which to assemble the aircraft. In Hangar 1 the aircraft were uncrated and the wings and tail assemblies reattached to the fuselage. In Hangar 2 they were completed and checked before Sergeant Pilot G. M. 'Tub' Tubbink would make the first half-hour test flight, after which the Spitfire would be thoroughly checked again. During the next test flight 'Tub' would check the Merlin engine's supercharger operation, especially switching from 'low' to 'high' gear at altitude and *vice versa*. The aircraft's behaviour during a dive from a 'split S', accelerating to 430 kt (493 mph; 795 km/h) (20 kt 'into the red'), was also checked.

If this flight was satisfactory, the Spitfire was checked again and finally a half-hour aerobatics flight took place. All being well, the Spitfire then went to Hangar 3 where armament was fitted. Once this was completed, the Spitfires were ready for operational missions.

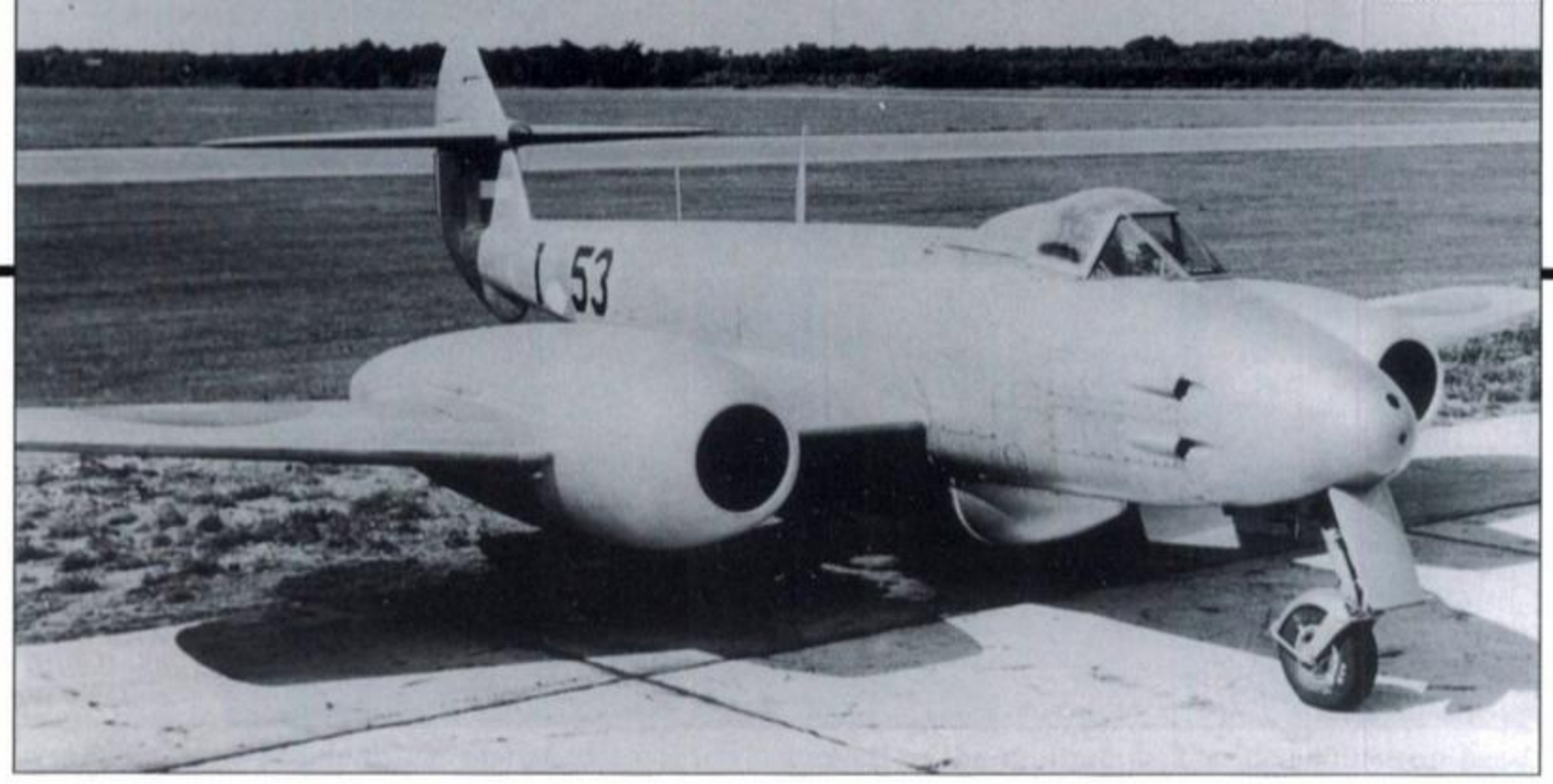
It took about two weeks to assemble a Spitfire. On 10 October the first example took off and by December a total of nine Spitfires was assembled and ready for action. The first six were flown by pilots from 'A' Flight from Kalidjati to Kalibanteng airfield, near Semarang, on 22 December.

On 6 November the squadron's name changed again and from that day it was designated 322 Spitfire Squadron. At the end of January 1948 six more Spitfire Mk 9s arrived, bringing 322 Spitfire Squadron up to operational strength, ready to replace No. 120 Squadron. The 20th and last Spitfire was completed on 20 March and the remaining eight aircraft were placed in storage at Andir as attrition airframes.

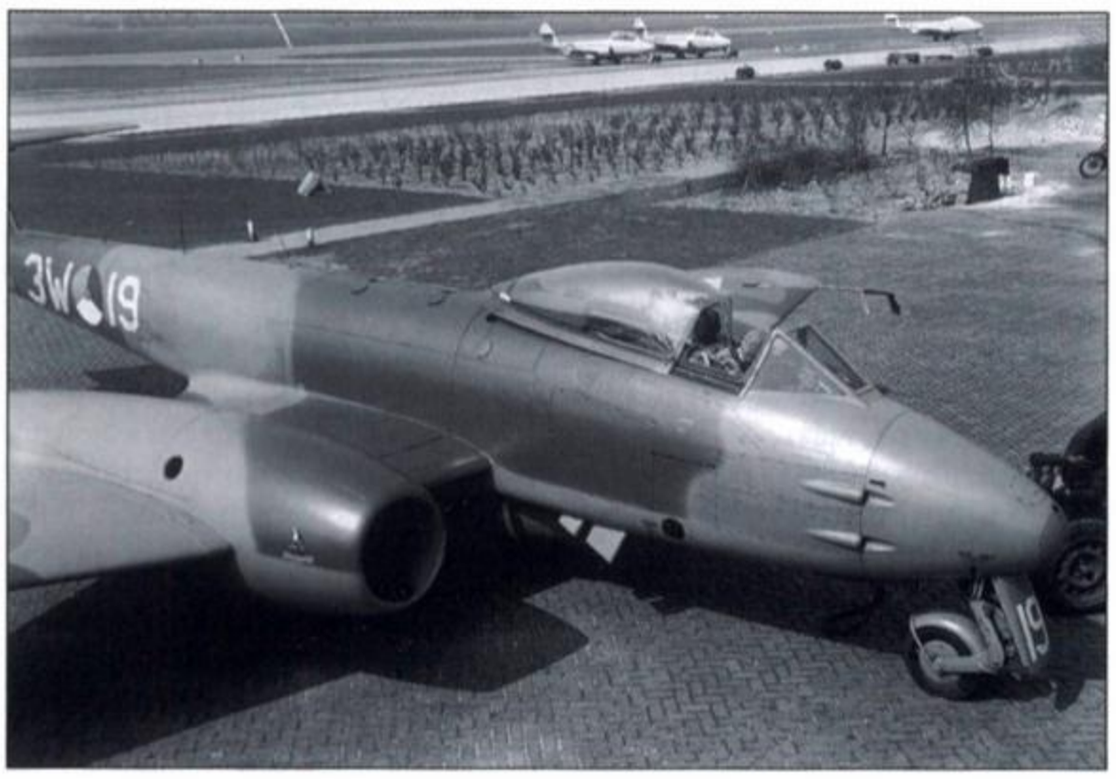


Above: H-52 (ex-MK205) was another aircraft to come to grief at Kalibanteng, having suffered what appears to be an undercarriage collapse. An overall green paint scheme was applied to many of the unit's aircraft in the Dutch East Indies.

After overhauls by Fokker in the late 1940s, the KLu's Spitfires were stripped of their camouflage and resprayed in overall silver. H-4 (ex-MK962, below left) is seen outside the Fokker factory. In 1951 the squadron's old '3W' code and new serials were adopted, seen here (below) on 3W-22, formerly H-99, ex-BS147 (an early-production Mk IX first flown in 1942).



Above: Still worn today by No. 322 Sqn's F-16 pilots, this version of the unit's badge is based on the original design adopted when No. 322 was formed as an RAF unit in the 1940s.



Above: I-53 (later 3W-33) was among the squadron's first jet aircraft – a batch of Meteor F.Mk 4s, originally finished in overall silver.

Left: The Meteor Mk 4s served with No. 322 Sqn only briefly before they were replaced by Mk 8s. As a reserve unit, No. 322 was the last KLu Meteor unit to re-equip with the Mk 8, adopting '3W' codes and Dark Green/Ocean Grey camouflage. The T.Mk 7 trainers in the background were among those acquired at the same time as the Mk 8s, for pilot conversion.

Kalibanteng airfield was shared with Kittyhawks from No. 120 Squadron and Austers from No. 6 ARVA Squadron. The Spitfire's 25- and 50-hour maintenance inspections took place at Kalibanteng, but for the 100-hour inspections the aircraft had to be flown back to Kalidjati airfield where a small group of technicians remained.

Meanwhile, an agreement struck between the Dutch and Indonesians on the future of Indonesia was breaking down. In July 1947 a 'police action' was ordered by the Dutch Governor General, involving army and air force units on both sides. 322 Spitfire Squadron finally went into action on 19 December 1947, when mock dive-attacks were made against rebels near Tjibatoe. The noise of the aircraft was apparently enough to persuade them to surrender to Dutch troops.

Renewed fighting

A ceasefire was agreed for August 1948, but both sides continued to regroup and when negotiations between the Dutch and Indonesian governments again foundered, a second 'police action' was launched on 19 December.

With this renewed action, Republican territory on Java and parts of Sumatra were taken. Soon 322 Spitfire Squadron, which had, up to that time, flown 1,400 hours and more than 800 operational missions, was flying air cover over Kalibanteng to protect the air base against air strikes. The base was busy, with Kittyhawks, Mustangs, Mitchells and Dakotas already in position.

Soon after, two Spitfires attacked and destroyed an enemy radio station near Solo, and attacked other targets. Air cover missions were also flown. Meanwhile, paratroopers were dropped over Plagoewo airfield near Djokjakarta, where the Republican HQ was situated, to take and secure the airfield and its runway so that an air bridge of Dakotas could fly in more troops, munitions, water and food. This action took the Republicans by surprise, and the Dutch Dakotas flew in 2,600 troops, 80 jeeps and other supplies to Plagoewo before sunset. During December the Republican's leaders, Sokarno and Hatta, were also taken prisoner and flown out of Plagoewo in a Mitchell.

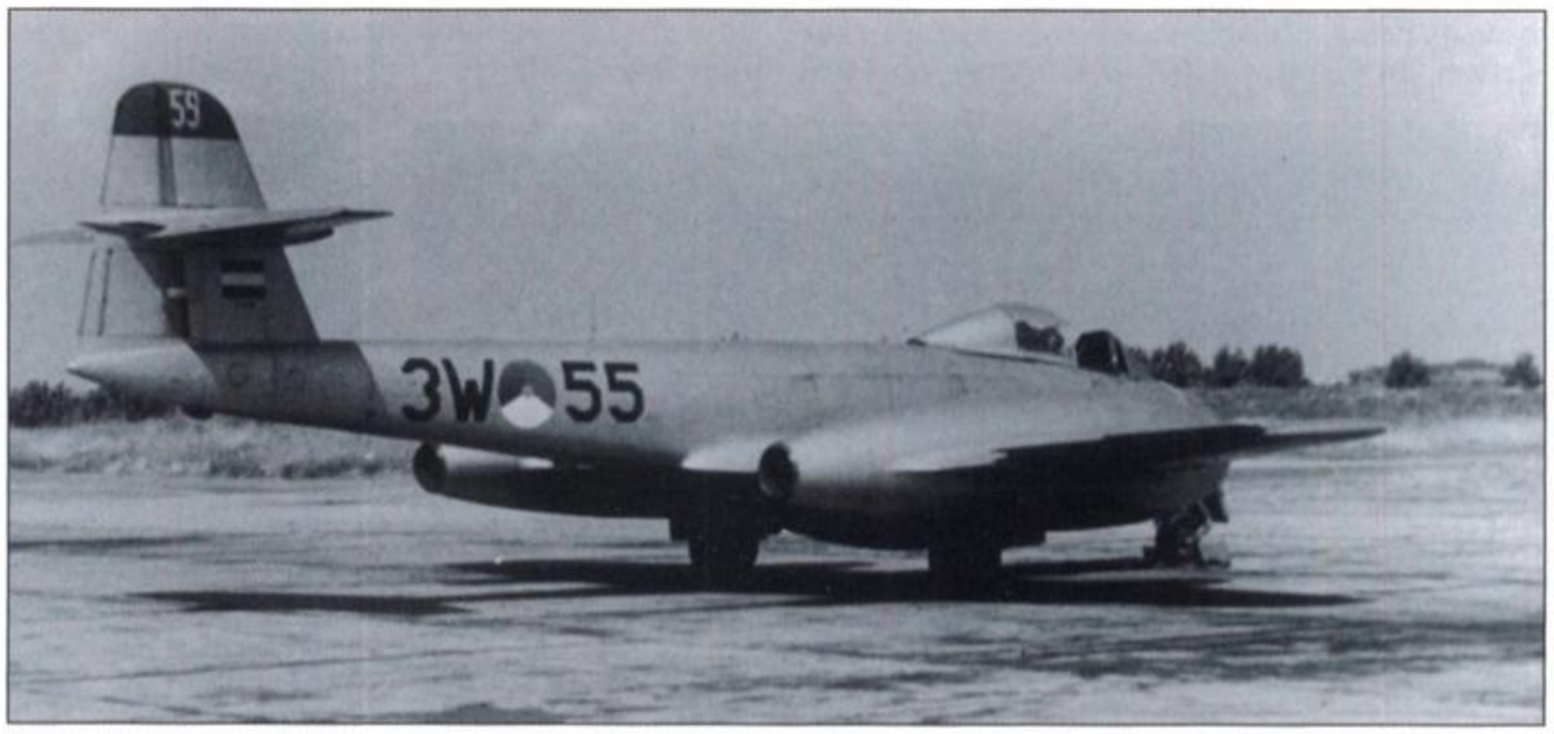
322 Spitfire Squadron continued to fly air cover, armed reconnaissance and escort missions until mid-1949 when, under considerable international pressure, the Dutch convened peace talks that ultimately led to the formation of an independent Indonesian republic in December.

From mid-year, 322 Spitfire Squadron flew escort for Dakotas on food and medicine drops and soon the Spitfires made the drops themselves using bomb rack containers. These were jettisoned over the sea before landing, as full flap could not be used with the containers attached.

As the Netherlands slowly withdrew from Indonesia, one of 322 Spitfire Squadron's last actions was to provide air cover for ground troops as they left Djokjakarta and Plagoewo. Flying operations ceased on 1 September and the squadron left from Tandjong Priok aboard MS *Tabinta* on 4 November, arriving in Ijmuiden on 1 December, the day after 322 Spitfire Squadron was formally disbanded. The Spitfires had arrived earlier in Rotterdam but remained crated until a buyer was found – they

Right: Initially, 322's Meteor Mk 8s were finished in overall silver, with a light blue tailfin tip.

Below: Squadron mascot Polly Grey perches on a pair of 20-mm cannon shells, before a suitably adorned Meteor Mk 8.



The quartet of Hunter Mk 4s formates for the camera. Both the Hunter Mk 4 and Mk 6 aircraft were camouflaged in standard KLu Dark Green/Dark Grey with silver undersides.

Sidewinder-capable Hunter Mk 6s eventually replaced No. 322 Sqn's Mk 4s. Initially, KLu Hunters carried unit code/serial numbers (3W-xx); later, a single type-code letter/serial number (N-xxx) was adopted.

were subsequently sold to Belgium.

Air force autonomy

During 1950, the Army Air Force Command of the Netherlands (Commando Legerluchtmacht Nederland) became Air Force Command (Commando Luchtstrijdkrachten), the first step towards autonomy. By then, the only remaining Spitfires in the Netherlands were those with the Jachtvliegschool (JVS – Fighter Pilot School) at Twenthe air base. In the spring of 1950 a JVS instructor, Captain Pilot H. C. Asjes, was given three months to reform 322 Squadron. Pilots were taken from Meteor squadrons, and Asjes checked them out in a two-seat Spitfire T.Mk 9 at Twenthe before a training programme was instituted.

At the end of July, 322 Squadron left Twenthe with nine Spitfires and deployed to Valkenburg for participation in Exercise Cupola, an international air defence exercise, planned for 25-27 August 1950. Two Dutch Gloster Meteor squadrons and a single Spitfire unit (322 Squadron) took part. During the exercise, French, Belgian and Dutch fighters were required to intercept American and British bombers trying to attack the continent. The exercise went well except for the last day, when, as 322's Spitfires flew back to Valkenburg, Spitfire Mk 9 H-2 disappeared and crashed near Etten-Leur, killing the 24-year-old pilot.

Fighting to reprieve 322

During the following months, as more Meteors were delivered to the Netherlands air force, the last Spitfires and, with them, 322 Squadron, were threatened with extinction. Captain Pilot Asjes wrote to Air Force Command, drawing their attention to the fact that 322 Squadron was the oldest fighter squadron in the Netherlands air force, with a rich and colourful history. It was decided that the squadron could continue its operations as an auxiliary unit – 322 Maandvliegsquadron (Monthly Flying Squadron). On 15 January 1951 Asjes became squadron commander and the unit was reactivated. One month later it was operational with a fixed staff of professional personnel supplemented by flying 'civilians'.

Reserve pilots who had served for a period of six years with the Royal Netherlands Air Force were given the opportunity to stay current on the Spitfire for three more years as a *maandvlieger* (monthly pilot). A *maandvlieger* was initially required to complete six hours of flying a month, though this was later increased to 12 hours, with a maximum of 24 per month. The squadron was still based at Twenthe, its main task being air defence, though air-to-ground firing was practised at a nearby range, and bombing at the air base.

During March, April and July the squadron participated in exercises, though the obsolete Spitfires could not keep up with modern machines. In the meantime, the Spitfires once again received their old World War II squadron code ('3W'). Single-seaters were serialled 3W-1 to 3W-19 and the two-seaters 3W-20 to 3W-22.

On 31 August the *maandvliegsquadron* moved to Soesterberg to await the delivery of Gloster Meteor Mk 4s. Operations continued, though day-to-day life on the squadron resembled that of a sociable flying club more than an operational unit.

In June 1952 the first Meteor Mk 4 finally arrived on the squadron and the Spitfire was at last phased out. With this change of equipment the unit's name changed again, to 322 Squadron. There were not enough *maandvliegers* current on the Meteor so it took 322 Squadron until April 1953 to become operational. The unit's task remained air defence and it operated with the Meteor Mk 4 for about a year until, in April 1953, the first Meteor Mk 8, built by Fokker, was delivered to the squadron.

Meteor trainers

322 Squadron also gained five two-seat Meteor T.Mk 7s for training. The Meteor Mk 8s wore the squadron's '3W' code, and the Mk 7s had 'I-x' codes. In May the commander of Commando Luchtverdediging (Air Defence Command) wrote to the Chief of the Air Force Staff in May 1953, informing him that the squadron had reached such an operational state that it could easily be deployed as a fully-fledged mobile unit. Thus, in the

Complete with a No. 322 Sqn badge on its tail, F-84F Thunderstreak P-214 is seen at Leeuwarden during the 1960s, while on strength as a target-tug.

Top: The first KLu F-104Gs were finished in anti-corrosion grey, but tactical grey/ green camouflage was soon applied. As the aircraft were deployed on a pool basis, they carried Nos 322 and 323 Sqn badges, one on each side of the tailfin.

Right: No. 322 Sqn's interceptor role included the so-called 'zoom flights' to intercept Soviet bombers. Here 10 of the unit's pilots are seen wearing the pressure suits necessary for these high-altitude interceptions.

event of mobilisation, the unit would deploy to Schiphol.

On 12 June 1953 the squadron had existed for 10 years, an event that was celebrated on 26 September with the acquisition of a new parrot mascot. The new Polly Grey was bought a couple of months beforehand. Tragically, this bird died two days before the celebrations. Another was found and once again the squadron was at full strength for the reunion held to celebrate the anniversary. This, the third Polly Grey, escaped twice: the first time, 'Sergeant Pilot' Polly Grey was found in a pigeon coop after an advertisement was put in a daily newspaper; on the second occasion, a television appeal was necessary, and the bird was handed over at a Hilversum TV studio.

A few months after the first Meteor Mk 8 was delivered the Spitfire was finally retired from service with 322 Squadron, the final day of operation being 4 June 1954. The remaining Spitfires were sold to Schreiner Aero Contractors, a civil operator which flew the Spitfires for several years from Texel airfield in the target-towing role.

Sgt Polly Grey's flight in one of No. 322 Sqn's TF-104Gs was marked with this certificate.

LOCKHEED F-104 STARFIGHTER

FLIGHT CERTIFICATE

know ye by these presents that

Sergeant Polly Grey

is an honorary member of the

ROYAL ORDER OF STAR-RIDERS

having flown in the two-place version of the Free World's most versatile fighter on Feb. 23, 1965 piloted by:

Capt. A.J. Dickman

Hunters replace Meteors

The early 1950s were comparatively uneventful for 322 Squadron, although during the Hungarian uprising of 1956 the squadron was put on alert and flew with live ammunition. At the end of 1957 the Meteors were phased out and on 7 January 1958 the squadron received Hawker Hunter Mk 4s. As the Hunters required a greater degree of proficiency from their pilots, they would be only entrusted to regular aircrew. The *maandvliegerij* were therefore disbanded on 1 January 1958.

As staffing levels within 322 at this time were insufficient for an operational squadron, it was merged with 327 Squadron and adopted the identity of the former. Without any two-seat Hunter T.Mk 7s in its inventory, 322's former Meteor pilots were reduced to studying their pilot's notes with special care and undertaking high-speed taxi runs! If everything went well, the unit's flight commander would allow a solo flight with a chase aircraft. Instrument training continued to be practised on the Meteor T.Mk 7s. The Hunter Mk 4s were used as 'day interceptors', air defence remaining 322 Squadron's major task. In March 1958 the Hunters received the traditional '3W' squadron code. Exercises continued, the squadron deploying to Valkenburg for them and to Leeuwarden occasionally for live firing camps.

Back to Indonesia

The 1960s brought rapid change. The Dutch and Indonesian governments began talks concerning New Guinea, Indonesia taking the view that this territory should be part of the Indonesian Republic. Talks stalled and the United Nations was unable to find a solution. As Indonesia was continuing to prepare for war, the Dutch government decided to increase its military presence in New Guinea.

In November 1958 radar installations were flown to Biak and Woendi, with the aim of detecting air strikes. The political situation failed to improve and in April 1960 more Dutch troops were deployed. Under the operation name Plan Fidelio, the Koninklijke Luchtmacht (KLu/Royal Netherlands Air Force) established the Commando Luchtverdediging Nederlands Nieuw-Guinea (CLV-NNG – Air Defence Command the Netherlands New Guinea) consisting of one squadron of air defence fighters, a control and reporting centre on Biak and an alternate airfield on Noemfoer.

It was decided to send 322 Squadron to New Guinea, where it was re-established again with 12 Hunter Mk 4s and two Alouette II helicopters for search and rescue. On 30 May a group of core personnel left the Netherlands aboard the aircraft-carrier HrMS *Karel Doorman*, with the 12 Hunters and two Alouettes in its hangars. Hunter Mk 4s were sent in preference to the Mk 6s that also served in the RNAF, because the former had recently received a major 800-hour inspection; most Hunter Mk 6s were just becoming due for the same work. The carrier arrived at Biak on 6 August and work to assemble the Hunters began immediately.

Personnel from all squadrons within the Koninklijke Luchtmacht in Holland had volunteered to serve with 322 Squadron in New Guinea, and preparations for moving them began in August 1960. Some 250 ground crew left on 28 September by ship, arriving at Biak on 17 November.

An inspection of the runway at Mokmer airfield revealed that it, and most of the airfield, was in a terrible state, so it was decided to use the 1800-m (5,905-ft) long *karang* (coral) runway at Boroekoe, near Mokmer. The other pilots of 322 Squadron arrived on 18 November and flying operations slowly began.

With No. 323 Sqn, No. 322 Sqn made up the KLu's F-104G interceptor wing, its primary weapon being the AIM-9. D-8098, seen here at Leeuwarden (right), and D-8090, carrying Sidewinders (below right), were among the 95 Fokker-built aircraft delivered to the KLu.

Hunter Mk 4 N-101 had been completed in time for a test flight on 21 October and was therefore the first Hunter to operate in New Guinea. A Jaarlijks Oefen Programma (JOP – Annual Training Programme) was established, consisting of instrument and navigation training, night flying, air-to-air and air-to-ground firing, ground attack and interception missions, low-level and formation flying. In the circumstances, it was difficult for the squadron to meet the demands of this annual training programme.

Much work was done at Mokmer, including extending the runway and preparing the aprons and taxiways for Hunter operations. On 24 December flights to 'show the flag' were made over Seroei, home to a large number of Indonesian sympathisers.

In February 1961 flying increased a little, and on 1 March a section of four Hunters took off for the first time since their deployment to New Guinea. During that month, 322 Squadron reached its prescribed number of flying hours for the first time. In June the first major incident took place, when a small fire started in the exhaust of Hunter N-118. It was quickly extinguished, but three days later the nosewheel of this Hunter collapsed on landing, the aircraft being damaged beyond economical repair.

On 1 July an open day and air show was held at Mokmer. A new 'blister' hangar at Mokmer was officially opened on 14 July, allowing inspections and minor repairs to be carried out there. Before this, the Hunters had to be flown or transported over the road to Boroekoe. On 10 September 336 Squadron with its Dakotas arrived on Mokmer.

Indonesia invades

The political situation in the region worsened and on 18 September Indonesian infiltrators were dropped near Sorong in western New Guinea. In December, President Sokarno finally mobilised his armed forces to 'liberate' New Guinea. In January 1962 an RNAF Neptune spotted three Indonesian vessels off the coast; two fled, but the other was fired on and set ablaze by the Royal Netherlands Navy.

At this point it was decided to strengthen 322 Squadron with the Hunter Mk 6, able to carry Sidewinder air-to-air missiles, but no combat between the CLV-NNG and Indonesian air force took place. Indonesian actions were somewhat sporadic until 8 May, when paratroopers were dropped near Teminaboean and Kaimana, both locations out of reach of the Royal Netherlands Air Force. To solve this problem Jefman airfield near Sorong and Utarom near Kaimana were activated (Operations Giraffe and Uiver, respectively) and a pair of Hunters stationed at each. In the meantime, at Mokmer 322 Squadron was divided into tactical and air defence flights.

With the assistance of the UN an agreement was brokered between the Netherlands and New Guinea and, after the ceasefire on 18 August, the CLV-NNG was disbanded and the Royal Netherlands Air Force could return home. 322 Squadron had not been required to take any action against the Indonesian air force.

Two Hunters made the last flight by the type in 322 Squadron service on 28 September. On 1 October the unit was disbanded and four days later its pilots left for Schiphol in a KLM DC-8. Hunter Mk 4s to have seen service with 322 Squadron in New Guinea were N-101, N-104, N-105, N-107, N-108, N-110, N-111, N-112, N-118, N-120, N-123 and N-135. Hunter Mk 6s with 322 Squadron in New Guinea were N-201, N-202, N-209, N-210, N-219, N-220, N-222, N-224, N-232, N-264, N-270, N-273, N-277 and N-279. The squadron also employed Alouette IIs H-4 and H-5.

Reactivation and F-104s

Two years passed before the unit was reactivated, at Leeuwarden on 1 August 1964. The first three F-104Gs for 322 Squadron had arrived at Leeuwarden for training purposes on 22 June (serialled D-8052, D-8057, D-8060). The squadron now had a new all-weather interceptor (AWX) tasking, its pilots coming from Hunter and F-86K squadrons and converting to the F-104G at Twenthe.

During 322 Squadron's tour in New Guinea, 'Sergeant Pilot' Polly Grey was left behind at Soesterberg with 326 Squadron, which later passed into 325 Squadron. When 322 Squadron was reactivated, the mascot was returned by a

Above: From 1970 F-104s took over the target-tug role from the F-84F and continued in the role until the early 1980s. This example carries a high Alkan Soule Dart and its associated equipment.

Left: With the arrival of F-16s, a number of KLu F/RF/TF-104Gs were sold to Turkey. Seen here on 25 August 1980, two F-104Gs with Turkish markings, but retaining their KLu serial numbers, prepare to leave Leeuwarden on delivery.

Below: A picture of Polly Grey is handed to the aircraft's pilot on the occasion of the arrival of the squadron's first F-16A (J-221), on 11 November 1979.

Above: A No. 322 Sqn F-16A leads a formation representing four of the KLu's main jet types of the post-war period, all of which served with No. 322 Sqn. Both the Meteor F.Mk 8 (VZ467/'01', wearing the codes of No. 324 Sqn) and the Hunter FGA.Mk 9 (XF435/'B', No. 325 Sqn markings) were RAF machines painted in KLu markings for the historic photo call, though only on the starboard side of the aircraft. The date was March 1981.

pilot from 325 Squadron. Captain A. J. Diekman checked out the parrot in an F-104G and subsequently he became an honorary member of the Royal Order of Star-Riders. (Sadly, Polly Grey died on 15 November 1971, when he escaped from his cage. A new mascot, Polly Grey V, was found fairly quickly and the squadron was at full strength again.)

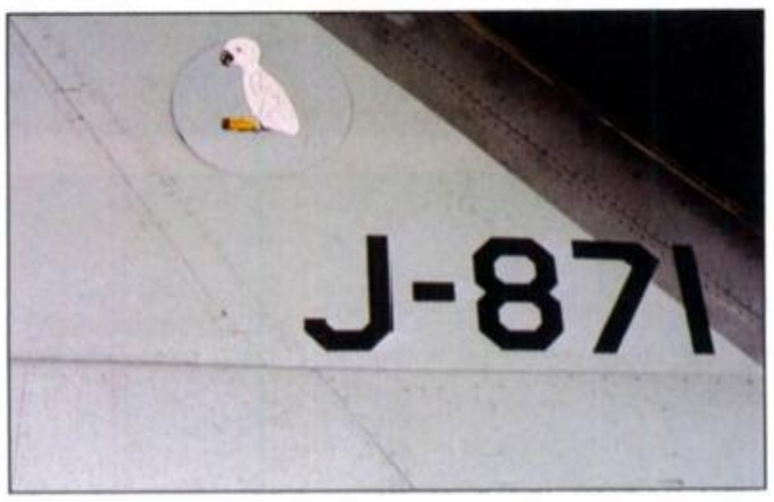
From 1 October 1965, 322 Squadron was fully operational and was required to be on QRA (Quick Reaction Alert) with 323 Squadron, also based at Leeuwarden. Two pilots, one from 322 Squadron and one from 323 Squadron, were on QRA around the clock, their Starfighters equipped with Sidewinder air-to-air missiles on the wingtips and often fuel tanks underneath the wings (from 1968 the Sidewinders were relocated to a so-called 'skid' just behind the nosewheel and the tanks were moved to the wingtips).

On 25 September 1972 Lieutenant K. Lokhorst (322 Squadron) and Lieutenant E. Wesselius (323 Squadron) scrambled to intercept an RA-5C Vigilante from the US Navy, but then a Sector Operations Centre asked them to go after an unidentified flying object coming from the north. Moments later a Tu-95 'Bear' was intercepted, making this the first interception of a Soviet aircraft by a Royal Netherlands Air Force fighter. To catch the Soviet bombers, which cruised at 60,000 ft (18288 m), pilots had to train at even greater heights (up to 75,000 ft/22960 m). During these so called 'zoom flights' a partial pressure overall and a full pressure helmet were worn. A 'zoom flight' started at approximately 35,000 ft (10668 m) at a speed of Mach 2. The pilot then pulled his Starfighter up into a 45° climb. At 65,000 ft (19812 m), dry thrust was selected and a parabolic route maintained. 'Zoom flights' were discontinued in 1975, as they were deemed to be of little practical value.

Another task of the squadron was target-towing, which was carried out with an F-84F Thunderstreak until 1970, when the F-104G Starfighter took over the role. Initially, a nylon flag was towed by the tug aircraft, but they were later replaced by a French Alkan Soule Dart. This system was evaluated and tested by the Koninklijke Luchtmacht from 1969 and purchased in 1972. The Alkan Soule Dart is a dart-shaped target consisting of a hollow shaft approximately 17 ft (5.2 m) long, with three metalled polyvinyl fins. Beneath the right wing of the F-104G a drum held 1,640 ft (500 m) of nylon cable, the target itself being carried under the left wing with its nose in a launch 'quiver'. The Dart was able to register hits and misses within 9.85 ft (3 m) of the Dart and transmit results to a ground station. After a sortie, the Dart was dropped over the airfield on a parachute, repaired and made ready for the next mission.

To this day, the unit keeps a parrot mascot. Here Polly Grey is seen with Henk Jan 'Pollykeeper' Meeter in the Leeuwarden crew room.

During a visit to another KLu base, No. 322 Sqn F-16 J-871 was 'zapped' with this revised version of the unit's badge – a featherless Polly Grey!



Mock bombing raid on train

In 1977 322's Starfighters were employed in an unusual action to free hostages aboard a train, hijacked near De Punt by eight terrorists on 23 May. Negotiations with the hijackers did not bring a resolution, so a rescue involving Marines and other special police and armed forces was planned. The train was standing in a gentle curve so there was a chance that anyone approaching the train would be spotted. The hijackers would have to be taken by surprise, and it was for this reason that the Starfighters were called in – their afterburners would be used to startle the terrorists and, hopefully, scare them into submission.

A trial run was held at Gilze-Rijen air base on 9 June, for which a train was positioned on the middle of the base. Though intended to be secret, the trial run attracted a sizeable crowd of onlookers. The 'attack' on the train was to be made lengthways to maximise the surprise, pilots being instructed to ignite their afterburners when the 'pipper' on their gunsight was on the train. This would produce the loudest possible noise. The rescue action itself was planned and ready the following day, as hopes of a negotiated settlement faded.

At 04.53 on 11 June, the first of six Starfighters (callsigns LIMA-1 to LIMA-6) swooped, flying at approximately 100 ft (30 m). Simultaneously, explosives arranged around the train were detonated so it appeared that the Starfighters were actually bombing the train. Snipers fired for two minutes to stop the hijackers moving through the train, after which Marines moved in. The aircraft flew over the train from the left and right alternately, at one- to two-second intervals, at a speed of 420 kt (482 mph; 776 km/h). A total of three passes was

This eight-ship formation of Leeuwarden-based F-16s includes at least five 322 Sqn aircraft and a pair of 323 Sqn aircraft.

Above: The KLu was among the start-up partners for the European multinational F-16 programme, those aircraft delivered to the KLu being built by Fokker-VFW. J-257 was the last of 20 Block 10 aircraft which followed 12 Block 1s and 14 Block 5s. The balance of the 213 KLu F-16s were Block 15 machines.

made. At the end of the action, two passengers and six of the eight terrorists were dead.

'645 Squadron'

At Leeuwarden, Starfighter operations by both squadrons continued, each using F-104Gs from a common pool of Starfighters after 1968. These aircraft wore a 322 Squadron badge on the left side of their tails and a 323 Squadron badge on the right. On 16 May 1979 both squadrons at Leeuwarden were combined as '645 Squadron' prior to the delivery of General Dynamics F-16s later that year. Ground crew and pilots were trained for the introduction of this new agile fighter.

The Starfighters were slowly phased out at Leeuwarden and subsequently sold to Turkey, though a few remained as target tugs.

On 1 August 1979, 323 Squadron was deactivated ('645' Squadron having also ceased to exist). 322 Squadron received its first F-16s a few weeks later. Pilots were retrained at the TCA (Transitie en Conversie Afdeling – Transition and Conversion Section) at Leeuwarden for their new roles of fighter-bombing and day interception. On 11 November the first F-16A (serialled J-221) was delivered to Leeuwarden and on 1 May 1981 322 Squadron was operational again, as the first KLu F-16 squadron.

In truth, it was only partially operational, as some work had to be done on the air-to-ground tasking, but by 1 September the squadron was fully operational. A few teething problems occurred during the transition to the F-16; 322 Squadron had been flying the F-104 for more than 16 years. New procedures and much retraining was required, and 322 Squadron's personnel worked hard. The first accident and F-16 loss occurred on 3 June, when a pilot ejected from F-16A J-237 over a lake in the northern Holland, after an engine flame-out.

On 11 September 1981, members of 323 Squadron kidnapped Polly Grey. Whether this had anything to do with the disappearance of 323's flag nobody knew, but this outrage was too much. Over Leeuwarden's loudspeakers, the formation of the P.L.O. (Polly Liberation Organisation) was announced, effective from 06.00 Zulu. In the end, deputy base commander Alwon mediated between both squadron commanders (Droste and Vogelpoel), moved to a 'neutral' part of Leeuwarden and arranged the 'hand over' of 323's flag and 322's parrot mascot. On 27 January, Polly Grey flew in an F-16 for the first time. The parrot sat on the legs of the squadron commander, in its cage, the intention being to make Polly the first 9*g* parrot in the world; unfortunately, when pulling just 3.5 *g*, Polly became unconscious.

An F-16A and F-16B of 322 Sqn sport the same serial number (J-241) after a prank by Leeuwarden ground crew.

On 13 September 1982 two pilots from 322 Squadron intercepted a Tu-142 'Bear' over the North Sea. Nico 'Disco' Dijxhoorn and Heinz 'Bozz' Manderfield intercepted the aircraft, which was in the area because of the implementation of NATO's Exercise Northern Wedding.

Over the years, 322 Squadron trained for and joined a number of exercises in the Netherlands and abroad. Low-level flying was and still is practised in Canada, from Goose Bay. In 1991 the Dutch F-16 solo display team was flown by a pilot from Leeuwarden, the climax for the team being an appearance at the International Air Tattoo at RAF Fairford, where it received the International Display Sword for the best flying display by an overseas participant. The F-16 was flown by Captain Zwaart of 322 Squadron.

A few years later, on 31 August 1989, Polly Grey once again came to grief. In circumstances that are unclear, Polly Grey died while in the custody of two 323 Squadron pilots in a QRA hangar. 322's pilots refused to fly until a replacement Polly was found and a service order was necessary to get some pilots, due at an exercise at Volkel air base, into the air again. On 6 September at 03.22, the 'last post' was played and the squadron's flag was lowered. A replacement Polly was found.

In the 1990s, more serious tasks have occupied 322 Squadron. In October 1993, the unit deployed to Villafranca, Italy in support of Operation Deny Flight for a period of six months. Most missions were combat air patrols in the air defence role, though ground-attack missions remained an option. The detachment at Villafranca consisted of eight F-16s from 322 Squadron and four F-16A(R)s from 306 Squadron, the latter with a reconnaissance role. This period passed without major incident until 322 Squadron had to deploy to Villafranca again in March 1995. On 24 March the first of a total

F-104 continued to operate as target-tugs into the F-16 era with the squadron. Here, the three units based at Leeuwarden in the early 1980s are represented – Nos 322 and 323 Sqns, the TCA and target-tug flight.

F-16 special schemes

The tailfins of various No. 322 Sqn F-16s have provided a canvas for a variety of special colour schemes commemorating notable milestones in the history of the unit and its association with the type. The squadron's 40th and 50th anniversaries in 1983 and 1993 were marked with bold red tail designs applied to J-252 (below) and J-215 (right), respectively. J-251 (below middle) was the first KLu F-16A to pass 2,000 flying hours, while the 10th year of F-16 operations at Leeuwarden saw F-16B J-259 receive a striped red/white/blue/orange tail.

of eight F-16s from 322 Squadron touched down for another six-month deployment, this time under Operation Deliberate Force, in which NATO aircraft undertook air strikes against selected targets.

UTVA-75 intercepted

On 6 April 322's Captain Tankink intercepted a UTVA-75 near Visoko airfield, forcing the aircraft to land. On 25 and 26 May the unit bombed an ammunition depot near Pale and F-16A(R)s of 306 Squadron flew post-strike reconnaissance missions. At the request of the United Nations, six additional F-16s maintained 48-hour readiness in the Netherlands, and deployed to Villafranca on 27 May. When the situation in the region calmed down again, these aircraft returned to the Netherlands on 20 June. Seven days later four MiG-21s were intercepted by Major Troost and Captain Rijnbeek.

On 8 July, with Srebrenica under threat from Bosnian Serb forces, the Dutch battalion in the vicinity requested air support, but this was declined by the UN. Three days later, the UN finally permitted a sortie by two F-16s from Leeuwarden, No. 322 Squadron crews destroying a bunker, a tank and an artillery piece.

On 30 August an attack was launched under order of the UN at 02.00 against several targets. F-16s from Leeuwarden flew CAPs and later bombed an ammunition dump near Gorazde and artillery pieces near Sarajevo. Between 30 August and 15 September the detachment was bombing ammunition depots and artillery on almost a daily basis. A total of 150 Mk 82 and Mk 84 bombs was dropped during this period. The Leeuwarden detachment was released again in October 1995.

Between October 1996 to April 1997, a third deployment from Leeuwarden to Villafranca took place in support of the IFOR forces and Operation Decisive Endeavour. Four Dutch F-16s were relieved by four Belgian F-16s on 11 October, making it a joint detachment. The six-month period was closed without incident.

A fourth deployment from Leeuwarden began in October 1998, this time involving just 323 Squadron, as 322 Squadron was about to transition to the F-16 MLU (Mid-Life Update) – the first KLu unit to do so. The first Dutch Mid-Life Update-modified F-16 (J-251) was rolled out at Woensdrecht air base on 4 July 1996 and seven days later it made its first test flight. Without the MLU, the Dutch F-16s would be at the end of their operational lives. A total of 138 Dutch F-16s will be modified under this programme, on two production lines at Woensdrecht, one with the Koninklijke Luchtmacht and one with Fokker Aircraft Services. The Initial Operational Capability for 322 Squadron with F-16 MLU aircraft was reached on 1 July 1998, and in August the unit joined the Red Flag exercises at Nellis AFB in Nevada.

A month later the first MLU F-16s from 322 Squadron deployed to Villafranca, returning without incident a few weeks later. On 12 January 1999, five MLU F-16s (J-003, J-006, J-014, J-018 and J-137) were in Italy again, after renewed fighting in the Kosovo area, this time operating (again with Belgian aircraft) from Amendola.

Formed out of a desire on the part of the dispossessed Dutch to take an active part on the fight against Nazi Germany, No. 322 Squadron (and, later, other Dutch units) provided the basis for a post-war KLu that was soon involved in the Netherlands' colonial conflicts of the 1950s and 1960s. With its 'new' F-16s, 322 Squadron is ready for the next century, equipped with modern aircraft with which to defend the Netherlands and carry out its NATO commitments.

Tieme Festner

MiG-29 kill over Kosovo

After Serb leader Slobodan Milosevic refused to accept an autonomy plan for Kosovo's Albanians, secured by NATO troops, Operation Allied Force was launched on 24 March 1999. On the first night of this concerted bombing campaign a 322 Squadron F-16 pilot scored an air-to-air kill – believed to be the units first confirmed victory over a manned aircraft. One of four pilots flying two pairs of F-16 MLUs on a SEAD escort mission from Amendola, the successful pilot's name was not released. The NATO package was flying north over Kosovo when the second F-16 pair was vectored by an AWACS aircraft toward three Serbian MiG-29s from Batajnica. Approaching one of the MiGs head-on and from above, the pilot of F-16 J-063 (seen here after the engagement, with an appropriate kill marking applied) fired one AIM-120 at a distance of 18 km (12 miles). The Dutch pilot then broke sharply and 30 seconds later saw his missile detonate; the kill was confirmed by the AWACS.

Gert Kromhout

No. 322 Squadron colours

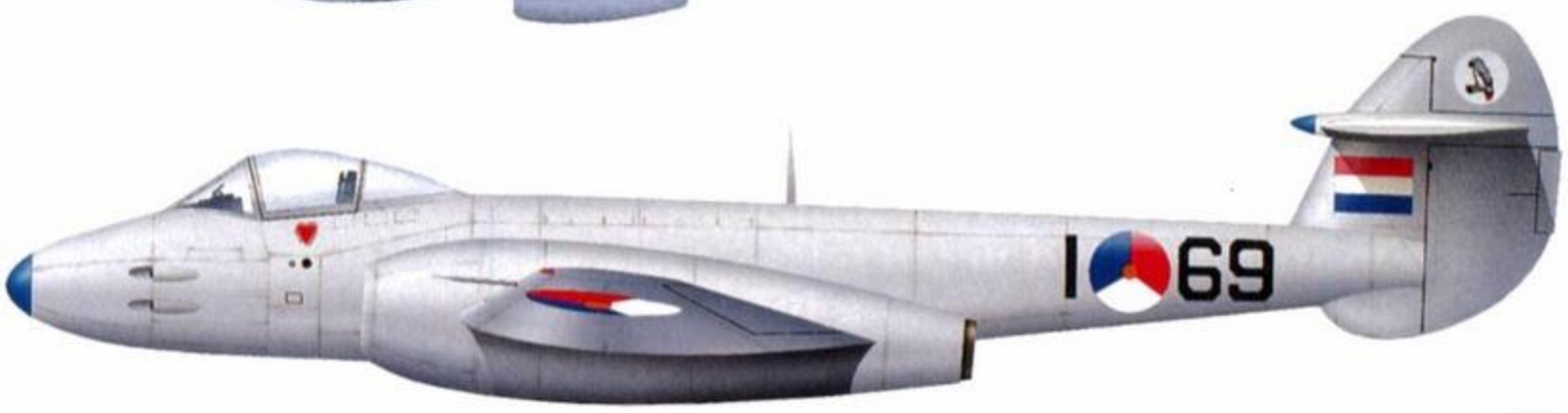
Supermarine Spitfire F.Mk VB
BM354 was delivered to No. 322 Sqn on 15 July 1943, having previously served with No. 485 Sqn, RNZAF. Here it is depicted in the standard RAF day fighter colours of the period (Ocean Grey and Dark Green), with Sky spinner, codes and fuselage band. A Dutch orange triangle marking and name are applied to the aircraft's nose. In early 1944 BM354 was passed to No. 222 Sqn and, in September, to No. 53 Operational Training Unit.

Supermarine Spitfire F.Mk XIVC
Seemingly little photographed, No. 322 Sqn's Spitfire F.Mk XIVs were largely engaged in the 'Diver' patrols against V-1 flying bombs. NH700, the CO's mount, was delivered to the unit on 14 March 1944, but was written off in an accident less than a month later. Shortly afterwards, the squadron re-equipped with Spitfire Mk IXCs for a fighter-bomber role in support of the Allied landings in Normandy. Note the squadron leader's pennant and Dutch orange triangle marking, and the unusual serial placement, in white, on the fin.

Supermarine Spitfire LF.Mk XVIE
TD137 is a late production Mk XVI with a teardrop canopy. No. 322 Sqn appears to have operated only a handful of these aircraft towards the end of the war in Europe. Assigned a fighter-bomber role, these aircraft often flew with 'clipped' wings to improve roll rate at low altitude. Standard Ocean Grey and Dark Green camouflage with Medium Sea Grey undersides were standard in RAF day fighters from late 1941 until the end of the war. Note the absence of the Sky 'Fighter Command' fuselage band, deleted from 2nd TAF aircraft during 1945.

Supermarine Spitfire LF.Mk 9
Built as Merlin 66-engined LF.Mk IX MH424, this aircraft was delivered to the RAF in August 1943, serving with No. 222 Sqn. Delivered to the KLu in 1946, it became H-53 (later H-106) and was among the aircraft shipped to the Dutch East Indies in 1946, direct from refurbishment in the UK. Seen here in Jungle Green with Light Blue undersides, H-53 was notable for its 'Donald Duck' nose-art and 'bomb' mission symbols. Sold in 1952, H-106 became SM-32 in Belgian air force service.

Gloster Meteor F.Mk 4
As originally flown by the squadron, the Meteor Mk 4s were finished in overall silver. Markings were minimal and restricted to national insignia, codes in the 'I-xx' range and a traditional 'parrot' badge on the fin. Camouflage was applied later finished in Dark Green/Ocean Grey and the squadron's wartime '3W' codes applied to the aircraft.

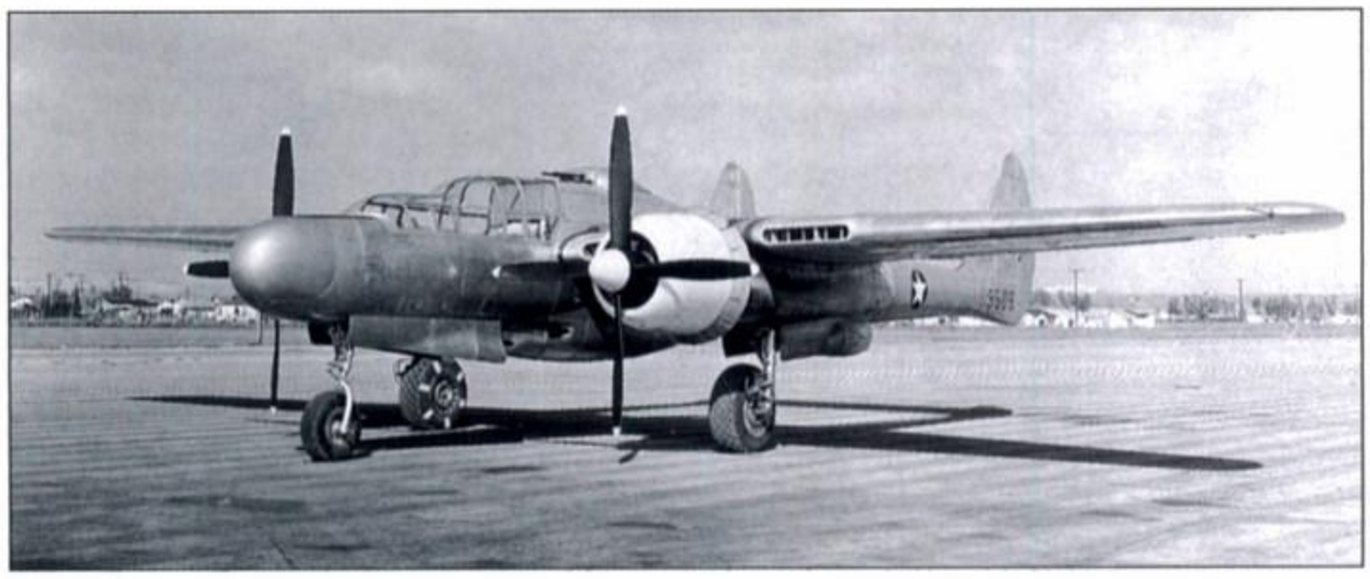


Hawker Hunter F.Mk 4
'N-110' is depicted as it appeared at Biak AB, Dutch New Guinea in 1960/61. The aircraft is finished in standard NATO Dark Green/Ocean Grey camouflage with light grey undersides. The spectacular tail marking was based on a West Irian flag, later adopted by the UN-supervised transitional government of 1962/63 and today in use by West Irian separatists.

Lockheed F-104G Starfighter
NATO tactical camouflage was applied to the KLu's entire F-104 fleet, including those tasked with interception, in the 1960s, replacing anti-corrosion grey. Fokker-built D-8304 is seen in interceptor configuration with wingtip fuel tanks and a pair of AIM-9 Sidewinders on underfuselage rails.

Midnight Queen, Nocturnal Nemesis, Lady in the Dark. These were all names applied to individual Northrop P-61 Black Widow night-fighters but they apply equally well to the type as a whole. Designed for one purpose only – to hunt down intruding enemy aircraft by night and in bad weather – delays in its introduction led to most of the Widow's work being in offensive roles, from night patrols over enemy territory to night and daylight interdiction with rockets and bombs. The Widow was the biggest purpose-designed fighter aircraft of World War II, and the only Allied fighter designed from the outset for night-fighting. From it was spawned the F-15 Reporter, the first purpose-built spyplane. Compared to other American combat types, only a handful of these specialised aircraft were accepted into service, for a combat career lasting just over a year. A few years later they were gone, replaced by jets; a few aircraft lingered as testbeds, survey aircraft and, finally, fire-bombers.

Northrop P-61 Black Widow



Three weather-beaten P-61s fly in formation over Okinawa in 1946. They were operated by the 4th All Weather Squadron. Some of the weather they flew in took a heavy toll on the appearance of the aircraft, as evident on the closest Black Widow. P-61s (later F-61s) hung on for a few years after the war until more sophisticated night-fighters such as the F-82 and Northrop's own F-89 supplanted them. By 1952, eight years after their service introduction, they were declared obsolete.

Above: The XP-61 was one of the few Black Widows to fly in an unpainted state (apart from its yellow cowlings, a Northrop trademark for prototype aircraft). No radar was fitted and the turret was a dummy, but early testing proved that the basic design was a sound foundation for an effective night-fighter.

The evolution of aerial night-fighting took place in a relatively short period of time: during that devastating period in 1940, when the German Luftwaffe was relentlessly bombing England. The attrition rate of German and British aircraft was extremely high and it became too costly to bomb during the daylight hours, so most of the air action shifted to an arena of total darkness that was broken only by the raging fires below.

The intensity of the fighting and the emerging sophistication displayed in the night battles over England made the United States realise that it must develop a night-fighter that could cope with this type of warfare. The RAF had the lion's share of input as to what characteristics this future night-fighter should have. Northrop Aircraft had shown the most interest in the project and would be the company that dominated the subject of nocturnal warfare within the USAAF.

The requirements offered by the British were simple and to the point. Their suggestions were based on actual experience and there was no speculation or guesswork involved. Speed would not be the primary requirement. When RAF Spitfires were scrambled to intercept German bombers, it was found that by the time they reached altitude, the bombs had already been dropped and the enemy aircraft were egressing from the target area at full speed. This meant that a new fighter would need an extended loiter time over the patrol area: it must be able to maintain patrol for at least seven hours and still have enough fuel to meet the enemy in a high-speed engagement.

The fighter's remaining assets involved state-of-the-art intercept radar and heavy firepower. Northrop developed an aircraft that would stand up to anything in the air as far as devastating firepower was concerned. The original armament configuration designed into the X and Y models called for four 0.50-in guns in a top turret and four 20-mm cannon in the belly. All the P-61's firepower would be contained within the crew nacelle, as would its radar.

Most of the RAF's involvement in the Northrop project took place in 1940. The first contract was signed between Army Air Corps and Northrop on 30 January 1941, over 10 months before the United States was drawn into the war by the attack on Pearl Harbor. The initial contract was for $1,367,000 and called for two prototype XP-61s and two wind tunnel models. The models would be built in a 1/20th and 1/30th scale. Wind tunnel tests were conducted at Wright Field, Ohio and at the National Advisory Committee for Aeronautics at Langley Field, Virginia.

Twin tails

The twin tail booms were put into the configuration to enhance the stability of the gun platform in cases of very close pursuit. Head-on intercepts were non-existent in the night-fighting world, meaning that the defending aircraft would lock on to an intruder from behind, at whatever distance it took to make a positive identification, then line up the enemy aircraft for the kill. In many cases, especially where an i.d. could not be made from the intruder's exhaust pattern, the fighter would have to come in close, into the other aircraft's slipstream. This made it very diffi-

The Black Widow was by no means named for its colouring, the appellation having been decided well before Army tests proved a gloss black finish to be the best night concealment. P-61A-1 and A-5 models were produced in the standard fighter scheme of olive drab and neutral grey, as seen here. A number of aircraft, including the YP-61s, were finished in a matt black coat.

cult to control the pursuing night-fighter; with twin vertical stabilisers, one remained out of the turbulent stream and made control much easier.

Before the final plans for the XP-61 were finalised, numerous configurations were proposed. One had a single vertical stabiliser similar to that of the A-20 Havoc. The armament was moved around many times. At one time, there were two turrets (nose and tail) and, when these were discarded, there were two 0.50-in machine-guns in the belly and four on top of the crew nacelle. The four 20-mm cannon were located in the wings. The two-turret configuration called for two gunners, a pilot and radar operator. As the plans became more refined, the four machine-guns remained in the top turret and the four 20-mm cannon were inserted into the underside of the crew nacelle. The crew was set at three.

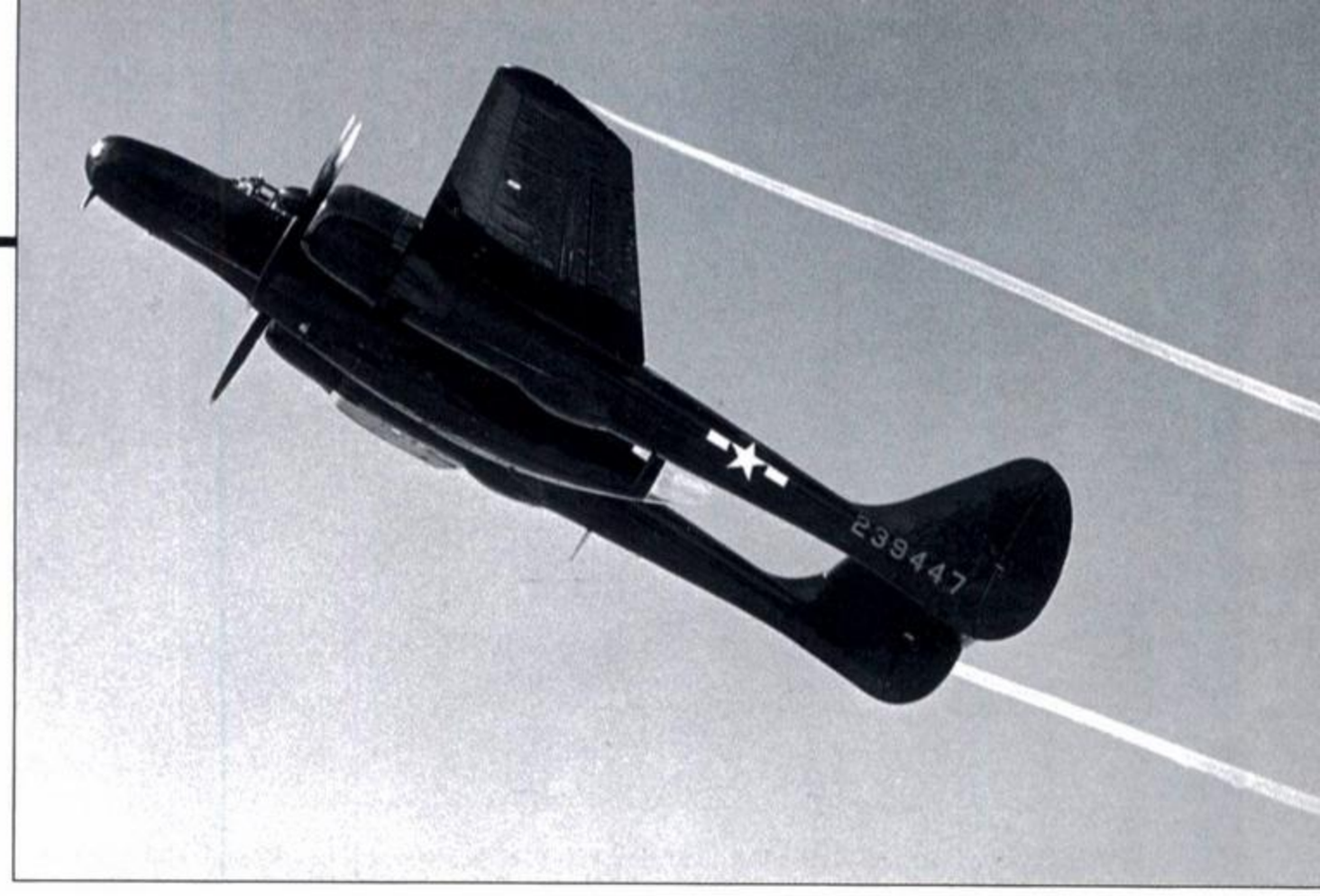
As the XP-61 was taking shape on paper, the Air Corps became more enthusiastic about the potential of the new Northrop fighter. On 10 March 1941, the Under Secretary of War signed a contract in excess of $5.5 million for the construction of 13 YP-61s. The urgency of this programme can better be understood when one realises that this contract was let only 38 days after the one calling for the two XP-61 models. The YPs would be flown and tested by operational test squadrons at Eglin Field, Florida and newly organised night-fighter training units.

Even as the final drawings were being completed for the XP-61, minor changes were made. Moving the 20-mm cannon from the wings to the lower portion of the crew nacelle brought two major improvements: air flow over the wings increased, and maintenance and access to the cannon would be very easy, with no need for work platforms. It had been determined that the Black Widow would have to carry more fuel internally than had been originally calculated, so internal fuel was increased from two tanks holding a total of 545 US gal (2063 litres) to four holding 646 US gal (2445 litres). Also, better armour plating protection for the crew was of the utmost importance.

Mock-up

During the summer and autumn of 1941, all of Northrop's efforts were directed to getting the XP-61 mock-up ready, completing wind tunnel tests, making small changes along the way and, above all, getting the XP-61 in the air. The early flight testing of the XP was critical in getting input for the already-approved YP-61 production. On 7 December, the Japanese struck Pearl Harbor and from then there was no extra time on any military project; the slow pace of manufacture of military materiel had quickened dramatically overnight. The Army Air Corps was looking beyond the XP and YP-61 to mass production of operational P-61As – and the XP had not yet made its first test flight.

An indication of the urgency surrounding the entire night-fighter programme within the Army Air Corps is given by the sequence of contracts signed before the XP-61 made its first flight. First was the contract sanctioning the two XP-61s and wind tunnel models, signed on 30 January 1941. Thirty-eight days after the XP contract was approved, another, for $5.5 million, was approved by the Under Secretary of War, giving the green light to the production of 13 YP-61s. On 24 December 1941, a letter of intent was issued approving 100 P-61s; Supplement One (dated 17 January 1942) endorsed an additional 50, and Supplement Two (26 February 1942) gave the go-ahead for a total of 410 Black Widows. The contract was worth an astounding $63,000,000 – and the XP-61 was still exactly three months away from its first flight! Fifty of these aircraft were marked for the Royal Air Force, with delivery of the first 12 Black Widows set for April 1943 and the remainder (38) for the following month. The US Army Air Corps would begin receiving its aircraft in May also, and the bulk of its first 50 P-61As were scheduled to be delivered between June and December 1943.

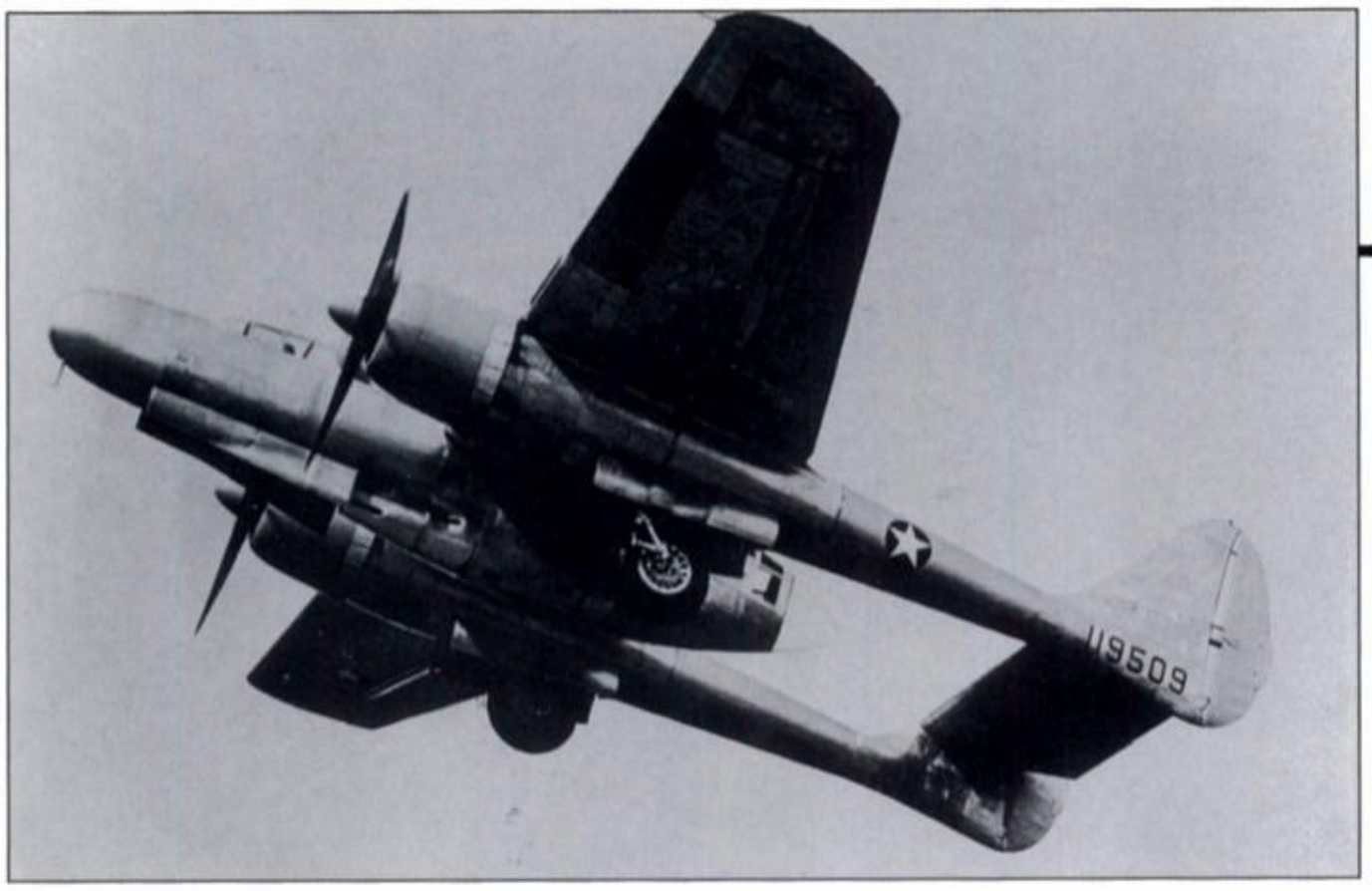


Before the YP-61s could even be produced, it became apparent that the all-important 0.50-in gun dorsal turret was going to be cut from Northrop's assembly line right after production of the A models was to begin. Boeing's big new super-bomber (the B-29) was getting top priority on gunsights and remote-controlled gun turrets. This was an acceptable deviation, as it was thought that the remaining 20-mm cannon would be sufficient. (The omission of the top turret was temporary. When there were sufficient examples for the B-29s, it became viable for Northrop to re-include the turret on assembly lines, which was at the beginning of the P-61B-15 series on the 201st B to be produced. An improved, redesigned fire control system turret was later installed in the P-61B-20 series, 84 of which were built.)

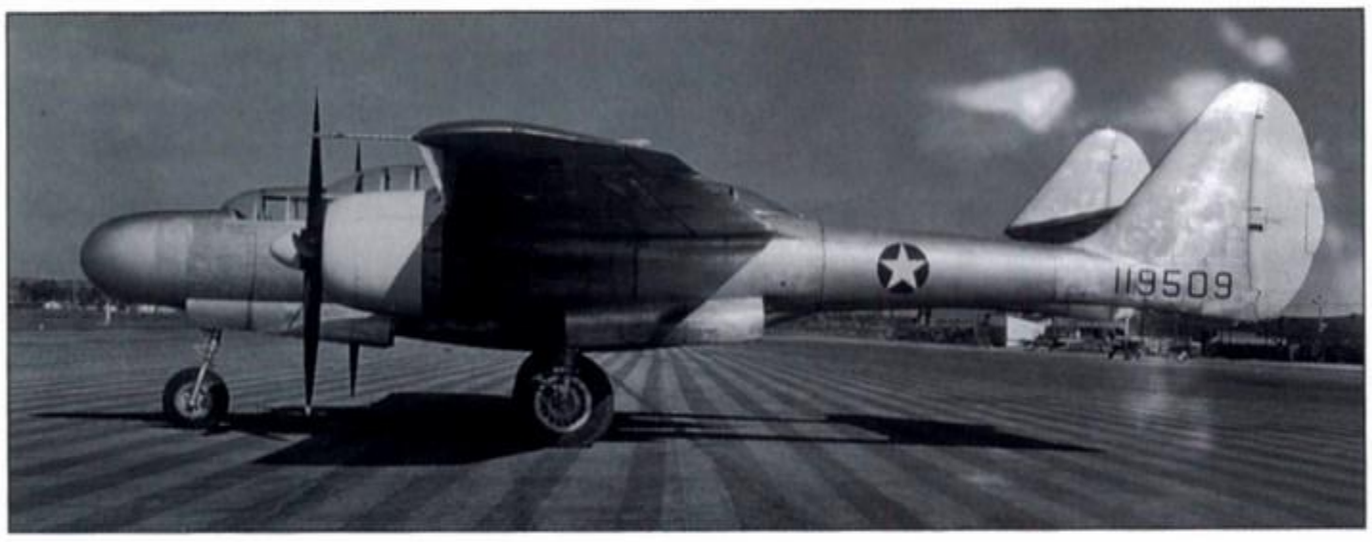
Late in the afternoon of 26 May 1942, Northrop test pilot Vance Breese made the first flight in the XP-61. It lasted just 15 minutes, but the performance observed by the large group of Northrop employees exceeded all

Despite being heavier than a B-25J (both empty and loaded) and only slightly smaller, the P-61B was a true fighter, capable of all the manoeuvres of much lighter aircraft. Only deliberate spinning, outside loops and sustained inverted flight were prohibited.

Although the first flight of the XP-61 was in the hands of Vance Breese, subsequent test flying was handled by John Myers, seen here with a P-61C. Conversant with the similarly-configured P-38, Myers's check-out in the XP-61 comprised a few minutes of cockpit familiarisation.



The first XP-61 takes off on, if not the first flight, a test flight early in the programme. The day before the XP-61's first flight on 26 May 1942, the Army ordered 1,200 aircraft. Features that distinguished the XP-61s from other Widows included the prominent rudder trim tabs, the curved windscreens, 1942-43 insignia, and yellow engine cowls.



In addition to the wind-tunnel models, the initial 1941 contract, valued at $1,367,000, called for two XP-61 aircraft, all engineering data, one mock-up and a set of photos of it, a set of reports covering all structural and flight tests conducted by Northrop, the report of Northrop's own wind-tunnel tests and 10 sets of operating and maintenance handbooks. After mock-up inspection, structural changes were ordered, adding 30 days delay' and another $38,137.50 to the contract. With other miscellaneous changes, the final cost, less government-furnished equipment, was $1,815,762.92.

expectations, and was confirmed by Breese's remarks. The Air Corps realised it was on the verge of adding a 'super weapon' to its inventory.

With contracts in hand for a large number of P-61s, Northrop was gearing up for mass production as the YPs were assembled; there would be no spare time once these 13 aircraft were completed. This took place in May 1943 when the AAC test pilots flew them for a series of structural tests. Shortly thereafter (8 July 1943), the YP-61 was officially accepted by the Air Materiel Command. Between 6 August and early September 1943, all but one of the 13 YPs were turned over to the Air Corps, the other remaining at the Northrop plant for training purposes.

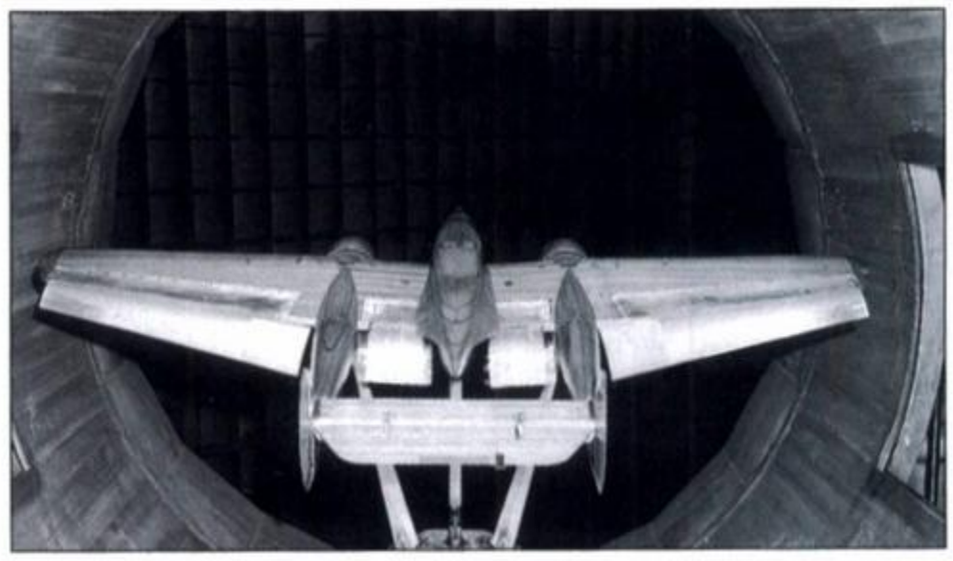
The P-61 had one weakness which the engineers had not foreseen and which became apparent when, on a test flight by John Myers, air pressure blew out the Plexiglas cone at the rear of the crew nacelle. The radome cover had been painted black, and the resultant heat from the desert sun which built up while the aircraft was on a stopover for refuelling weakened the Plexiglas. Once airborne, the radome collapsed, causing a change in air pressure within the nacelle, and the ensuing draught led to the failure of the tailcone. Myers was able to land the aircraft safely. Immediate steps were taken to strengthen the Plexiglas nose and so lessen the effect of the heat.

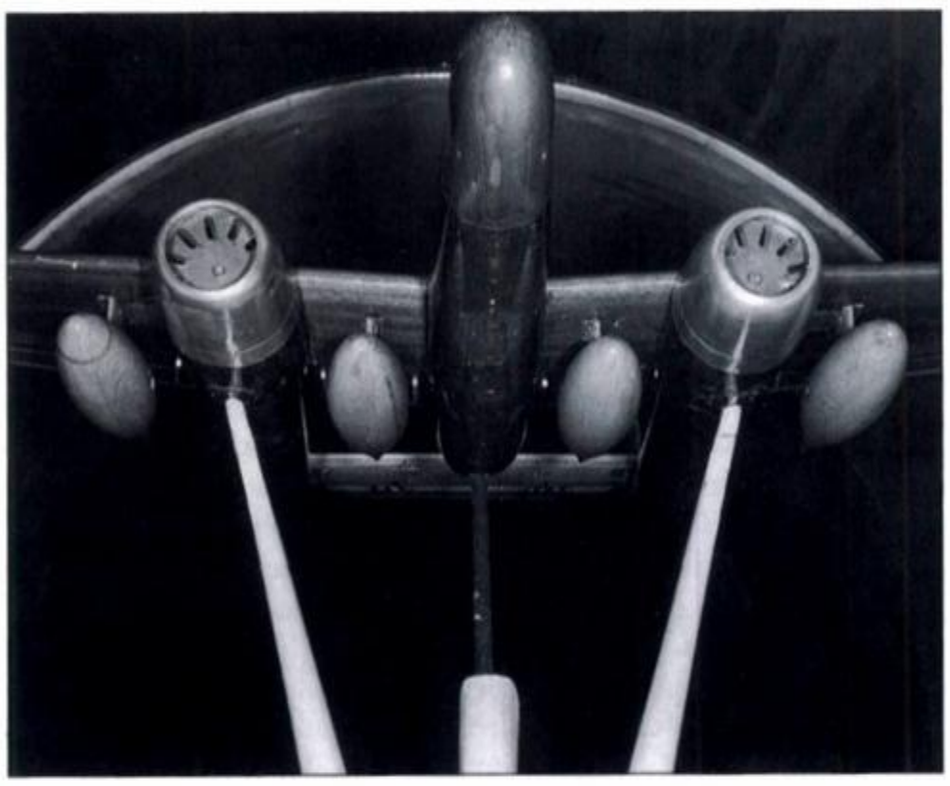
However, later on, there were isolated incidents where the tailcone collapsed in high-speed dives during combat missions.

The Black Widow goes black

During the early production run of the Black Widow, the first A models were finished in olive drab with a greyish underside. RAF night-fighter veterans stated that they had successfully used a flat black; the same applied to the German aircraft that flew combat after daylight hours. It was decided to conduct live testing with the P-61 colour schemes. One would retain its olive drab, one would have the flat black scheme and a third would be painted in an overall glossy black finish. The test was carried out at the Eglin Field complex with numerous searchlights. The OD

The initial contract given to Northrop called for two wind tunnel models to be built. One was to 1/20th scale and the smaller was 1/30th. The larger of the two was to be used in high speed and control characteristics testing at Wright Field, Ohio. The 1/8th model shown here was built at Northrop's expense. The tests on it were conducted at the California Institute of Technology.





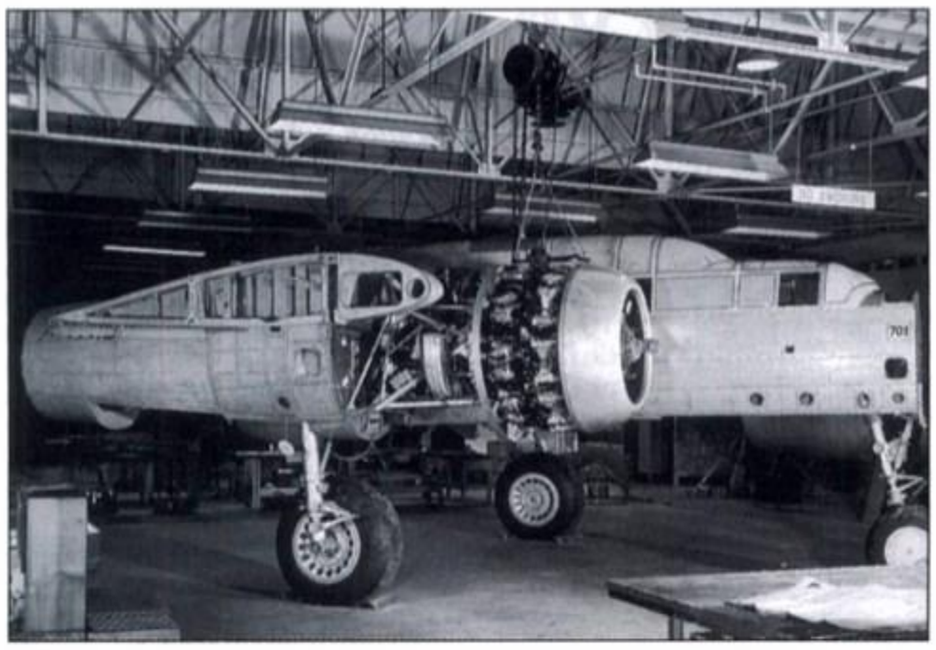
Additional wind tunnel tests were conducted with various configurations and sizes of drop tanks. The tanks proved extremely useful when the Widows were called to fly intruder missions over Japan in the spring of 1945.

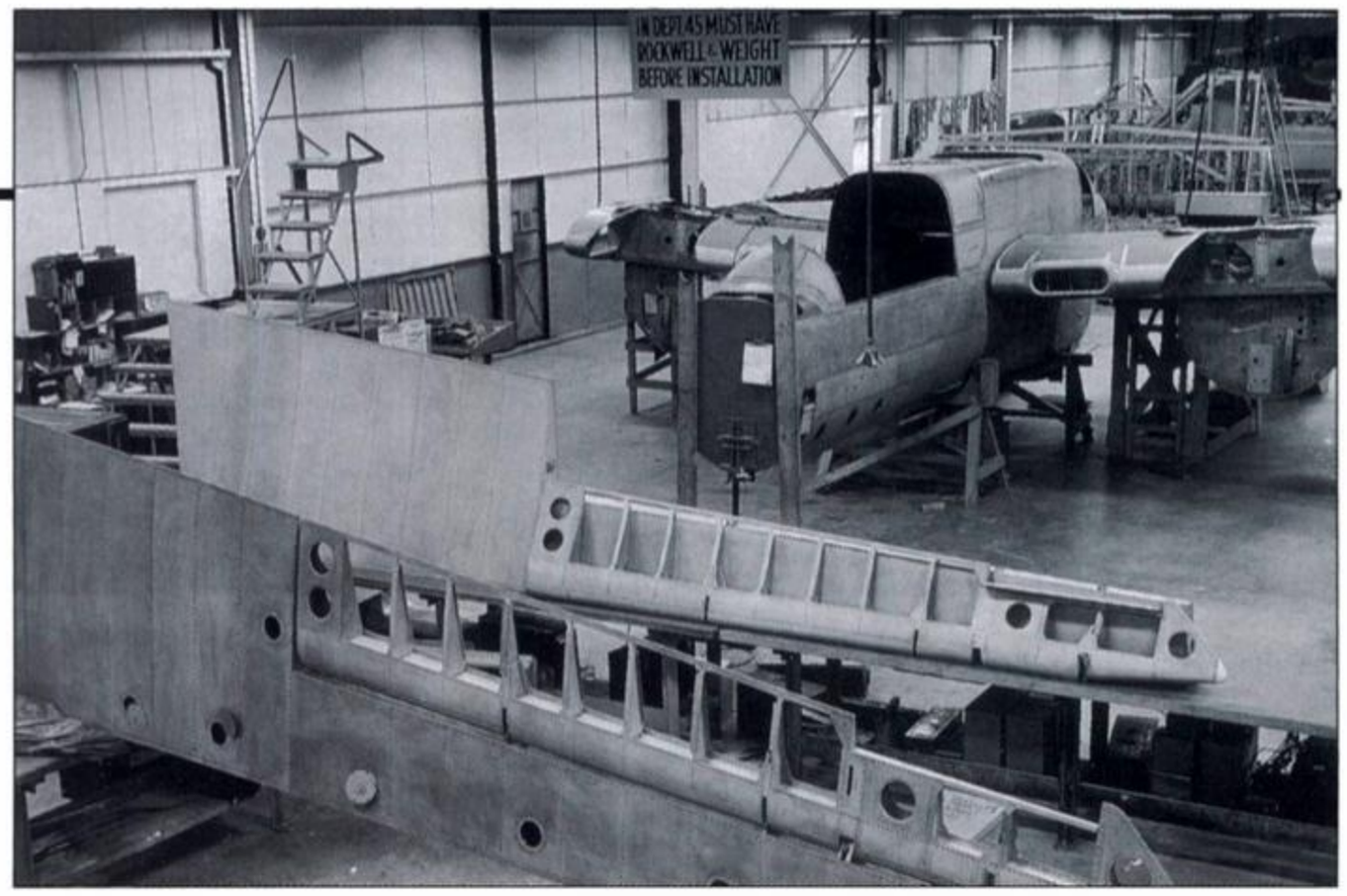
and flat black schemes were easily detected in the lights, but the gloss black finish was totally invisible and the observers never knew it had crossed through the beams of light.

The first series of P-61A-1s began rolling off the assembly line in October 1943. Their appearance was slightly different when compared to the XP and YP models, for the canopy covering the pilot's and gunner's compartments had been changed.

Also at this time, the Lend-Lease agreement calling for approximately 50 P-61As to be delivered to the RAF was cancelled. The exact reason was unknown but by then the YP-61 was nearing its production run, the skies over London had cleared somewhat and the Luftwaffe had changed its plan of bringing England to its knees. Thus, British priorities for the Black Widow had diminished considerably. However, the RAF did receive P-61A-1 (42-5496) for tests, held between 21 March 1944 and 22 February 1945. It was then returned to the USAAF.

One feature instrumental in the Black Widow's role during the later months of the war was the external racks. Most P-61s – from the As to the P-61B-2s, -5s and -11s – had two external stations. The P-61B-10 series was the first to introduce four external racks, a total of 45 of this variant being built. This feature gave some Widows the range to fly night intruder missions against mainland Japan, from as far away as Ie Shima and Iwo Jima, using four 310-US gal (1173-litre) tanks. There was one exception: the P-61B-16 series reverted to two external racks.



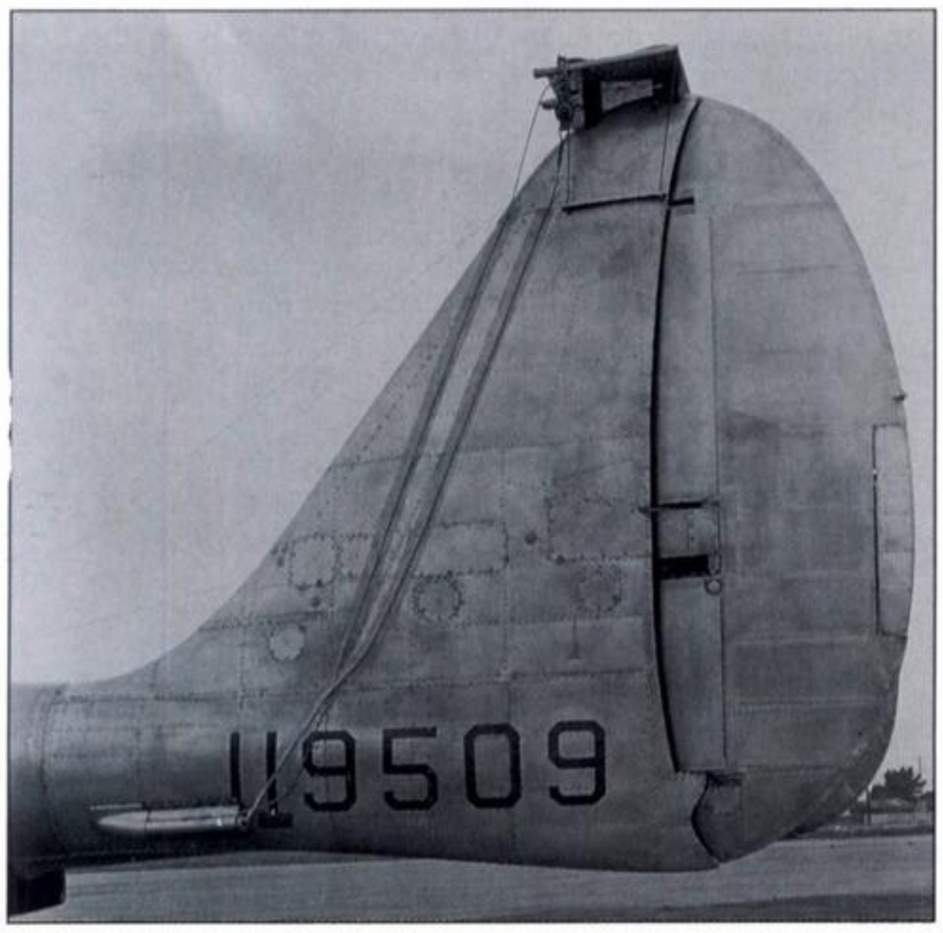


As the arrival of the early P-61 models was imminent, the USAAF formally established a training unit that would lay the groundwork for a sophisticated programme. On 15 July 1943, the 481st Night-fighter Operational Training Group was formed. Early training had been undertaken by the old 81st Fighter Squadron equipped with P-70s, and its personnel and equipment formed two new pure night-fighter training units, the 348th and 349th Squadrons. At the time, they were based in the Orlando AAB area, which is where the night-fighter programme began. The first commander of the new 481st Group was Lieutenant Colonel Winston W. Kratz, who would later become known as the 'godfather' of night-fighters.

Training group

The 348th and 349th squadrons formed the backbone of the new training group, and soon a third squadron was formed at Dunnellon AAB, Florida to help with the heavy workload. In addition to Dunnellon AAB and Orlando AAB, the latter then being the hub of night-fighter training, the new 420th NFS used Kissimmee AAF. The Air Corps had already determined how many operational squadrons it would need to protect its ever-increasing number of air bases, and three squadrons could not train enough men, so a fourth – the 424th NFS – was formed, using the P-70 as its main trainer. The 348th undertook primary instrument training, the 349th handled the transition training phase and the 420th prepared the aircrews for combat with operational training. The 424th concentrated on replacement training.

Approximately four months into the new training programme in Florida, the entire operation was moved to California's Hammer Field, near the city of Fresno. When the pilots arrived at the Hammer Training Complex, they usually had a lot of time in multi-engined aircraft (TB-25 and TB-26). With this experience, they were given an intense course in instruments, ground school and at least 20 hours of flying. It was at this level that the teams were created, forming a bond between pilot and R/O that in some cases lasted a lifetime. In the event of personality conflict, etc., team members were reassigned before training progressed very far.



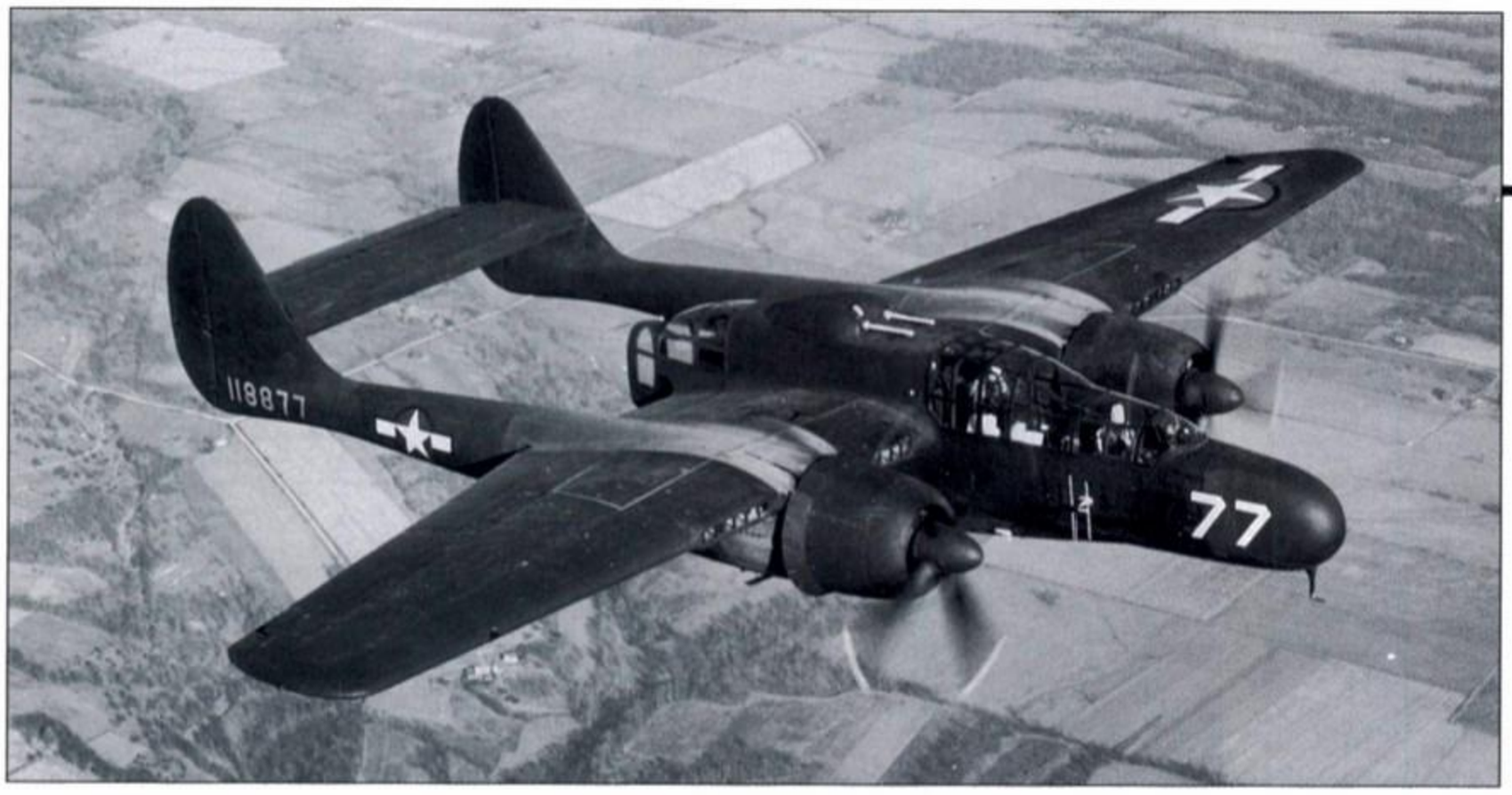
Above: The second XP-61 was rigged with a spin chute on the left vertical stabiliser, a safety precaution used during extensive testing by the Northrop pilots. In the P-61A Pilot's Operating manual, five manoeuvres were strictly forbidden: outside loops, inverted flight, normal spins, inverted spins and snap rolls.

The first of two XP-61s (41-19509) warms up for another test flight over the California mountains. At the controls is Northrop test pilot John Myers with an unidentified passenger. Due to problems obtaining a turret assembly from General Electric, dummy units were fitted to the XP-61s.

Above left: The second and final XP-61, 41-19510 (Ship 702), receives one of its Pratt & Whitney R-2800-10 engines during the slow process of producing a prototype. The first XP was promised nine months after the contract was signed and the second copy would roll out one month later. Both aircraft were officially known as XP-61-NOs.

Above: Producing the two XP-61s was a tedious process with none of the benefits found in mass production. It was strictly a hands-on job. This picture shows the first XP's trailing-edge section and aileron in the process of being constructed. All of the pieces to the puzzle are in close proximity, with no moving assembly lines to make it efficient.

Left: The finishing touches are put on the tail assembly for the second XP-61. It is ready to be joined with the remainder of the twin tail booms. The rudders have been finished in a tough fabric and the metal trim tabs have been fitted.



YP-61

As was the practice of the day, the XP-61 prototypes were followed by 13 YP-61 test or pre-production models for accelerated service testing by the Army. Most were delivered to Material Command at Wright and Vandallia Fields, Ohio in August and September 1943. Fourteen major and 15 minor deficiencies were identified. Altitude performance was said to be poor, as was visibility (made worse by turret gun flash and smoke). Lack of range and an over-complicated cockpit layout were other criticisms. By no means were all of the recommended improvements adopted.

Above: The YP-61s were involved in development of the problematic top turret. This aircraft, the second built, sports a two-gun installation and wears the 'last two' of its serial on the nose. A distinguishing feature of the YP-61s was the curved windscreen panels, which were replaced by flat armoured screens on production aircraft.

The first stages of the Black Widow mass production lines took shape when the YP-61s began to form up. There was a total of 13 Ys, four of which can be seen in this picture taken well into their assembly.

Above: This poor-quality but interesting colour image shows the 12th YP-61, with the Black Widow name beneath the pilot's cockpit. After the Army's tests, the YPs went to the Night Fighter Operational Training Group in Florida, and were used until the war's end to train night-fighter crews.

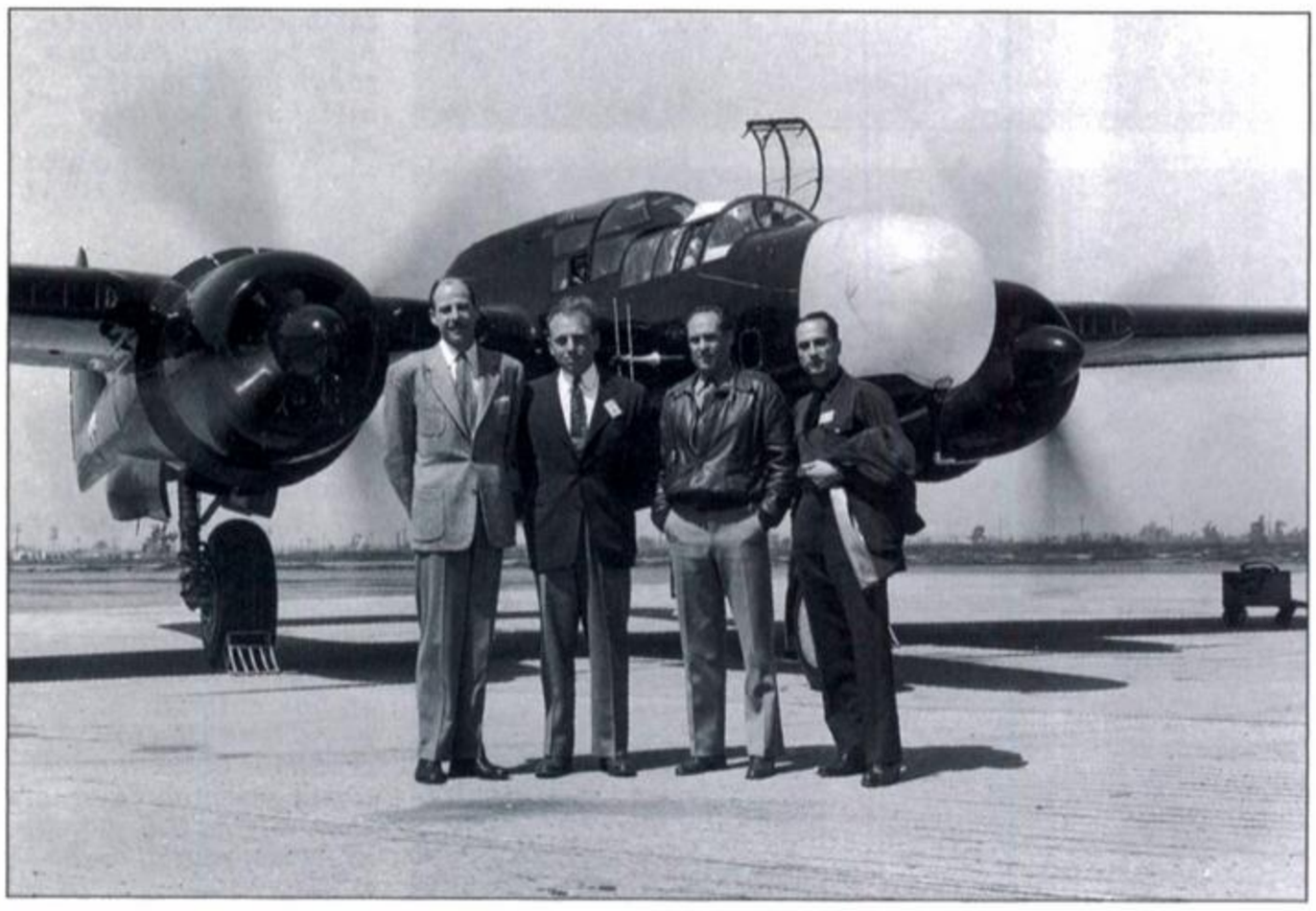
After three months of basic night-fighter instruction, the team began an intense 30-day period of high- and low-altitude night-flying, advanced interception techniques, evasive manoeuvres and the very important process of learning to work closely with Ground Control Intercept (GCI). Once they had mastered all this, aircrews were deemed ready for forward combat areas.

Black Widow in the ETO

The 422nd Night-Fighter Squadron was the first to fly the new Black Widows in Europe, as it had been the first operational squadron to train in the Black Widow. Those that had trained before had been indoctrinated in night-fighting, flying the converted A-20 (P-70). The 422nd arrived at Charmy Down on 7 March 1944. The unit was well trained and highly specialised in the new art, but there was a catch: it had not received any of its new aircraft, so had no way – yet – to challenge Luftwaffe night superiority.

The 'Green Bats' of the 422nd finally received their first P-61 on 23 May 1944. Eager as the squadron might have been to get into the battle, especially the imminent D-Day, it was not involved in the invasion of 6 June. It had not yet become operational in the new aircraft and was still waiting to be brought up to full complement. Its sister squadron, the 425th, did not receive its first Widows until 15 June 1944.

Some of the early combat sorties flown by both squadrons were against the dreaded V-1 'Buzz Bombs' launched against London and major English cities from hidden sites in France. These missions were known as



These four test pilots – Northrop's 'Four Horsemen' – were a vital part of the development and testing of all models of the Black Widow. They wrote the book on how to get the most from the aircraft, in any situation. From left to right are John Myers, Max Stanley, Harry Crosby and Alex Papana. Myers later went out to the Pacific to demonstrate the P-61 to the inexperienced squadron pilots. Max Stanley went on to test fly most of Northrop's flying wings; he passed away in January 1999.

anti-'Diver' patrols. The 422nd worked from Ford Aerodrome and the 425th from Hurn Aerodrome, both on the south coast of England. By the time they had been moved deep into France, both squadrons had destroyed nine V-1s. These were very dangerous encounters and, in many instances, the P-61s had to fly through enormous fireballs of exploding V-1s, and were almost brought down.

Future ace Lieutenant Herman Ernst of the 422nd recalls his first mission over the Channel. "The squadron's first operational missions were flown out of Ford Aerodrome against the V-1s. These were anti-'Diver' patrols. On my very first mission, we were patrolling at 7,500 ft when we spotted a 'Diver' below us at 2,000 ft. I dropped the nose of my P-61, pushed forward on the throttle and began closing on it. It was cruising at about 340 mph, so we were doing much better than that. All of a sudden, there was a loud boom and a tremendous amount of noise in the cockpit, to the extent that I couldn't hear a word my R/O was screaming at me. My first thought was that we had been shot down on our first mission. I aborted the mission and returned to base, even though the aircraft was responding to the controls. After landing, we discovered that the Plexiglas tailcone had blown out. The compression of the high-speed dive had done it. The squadron did not have any spare cones, so the problem was corrected by putting a flat piece over the opening."

Tracking the movement and history of the six night-fighter squadrons that fought in the ETO/MTO theatres would not be difficult, but detailing all the action they saw would fill volumes. The influence of the P-61 was all but non-existent in the MTO. The 414th, 415th, 416th and 417th Night-Fighter Squadrons had come from North Africa and into Italy equipped with Mosquitos and Beaufighters. High Command had considered giving them the new Northrop aircraft, but production was not keeping up with demand and these four squadrons were having good results with their British-made fighters. Only the 414th received its Black Widows while there was still a significant amount of Luftwaffe traffic at night, collecting its first P-61s on 20 December 1944. The 414th worked with the 422nd NFS during the Battle of the Bulge, and between 4 February 1945 and 10 April 1945 shot down five German aircraft.

The only other squadron to pick up the P-61 during actual hostilities was the 415th, which received its Black Widows from 20 March 1945. The other two got the new night-fighters at war's end, when there were few German aircraft. Of the four MTO NF squadrons, only the 414th scored kills in the P-61.

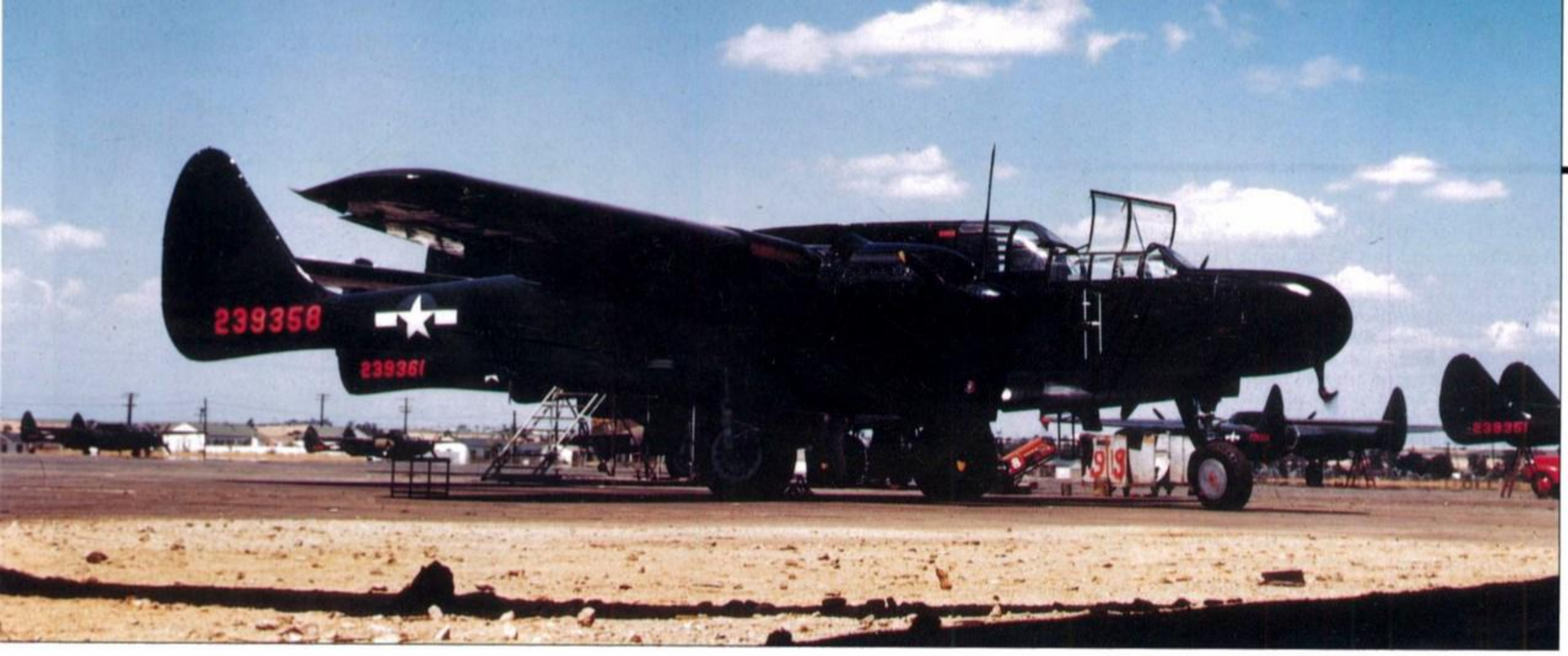
At the end of 1944, the situation within the 422nd and 425th squadrons was critical. They were far below the required number of operational aircraft. Lack of spare parts and replacement ships put each squadron down to 10 or fewer flyable Black Widows, and demand for them was higher than ever. In short, Northrop could not supply enough aircraft to fill the sudden demand, and with the lion's share of production going to the Pacific, nothing could be done to solve the problem. Everyone had to make do with what they had.

Defence to offence

The Luftwaffe used a wide variety of aircraft designed specifically for fighting at night, and a properly trained crew could hold its own against anything the Allies had to offer, including the P-61. By the time the new Black Widow entered the action, the nature of the war had changed drastically. The Luftwaffe was no longer the aggressor and its night efforts were directed toward defending its own airspace or trying to get personnel or supplies dropped to forces on or near the front. The P-61 entered the war right after D-Day and automatically assumed the role of aggressor or hunter. Although its job was to defend Allied assets, it

After the first test flights, the R-2800-25S engines on the first XP-61 were replaced by R-2800-10s at Pratt & Whitney's request. The new engines eliminated an oil trapping problem. In the background of this view, which show the engine change in progress, is a Vultee A-31 Vengeance, produced at Hawthorne by Northrop under licence. In the panic to increase aircraft production immediately after Pearl Harbor, priority was briefly given to production of the lacklustre Vengeance, and more delay was caused to the P-61 programme by the reallocation of resources and the removal from tools of parts under construction.

Below: An early model P-61A-1-NO in olive drab finish overflies California in 1944. A total of 45 Dash-1s was built.



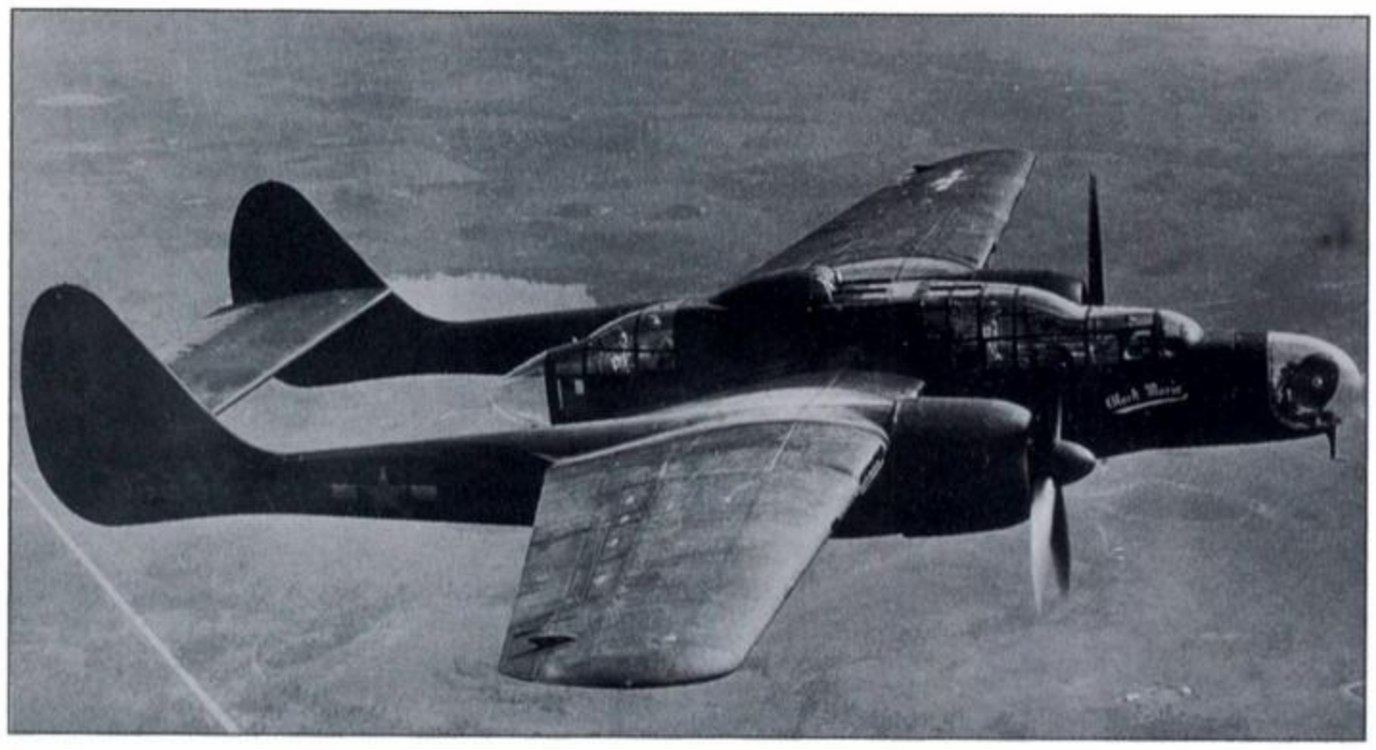
Turretless P-61A-10s fill the ramp at Hawthorne. From the 38th production aircraft (an A-1), the turret was deleted – it did not return until the P-61B-15, some 330 aircraft later.

ranged far over German soil to ferret out trains and road traffic. Beginning in mid-summer 1944, there were no safe havens anywhere in Germany ... day or night.

An old saying goes: when fighting a war and you find yourself in a sticky situation, you can never overstate the need for speed! This maxim must have been hanging on a wall in the Messerschmitt Design Bureau. From 1941 through 1943, the Germans produced some of the fastest aircraft seen over Europe, not all of which were jets. The Me 410 was capable of incredible speed and, one night, a Black Widow pilot got a demonstration. Lieutenant Van Neiswender, an experienced night-fighter pilot in the 425th, was patrolling his assigned sector on the very cold night of 25 December 1944. Germany was beginning its biggest counter-offensive of the war (the Battle of the Bulge), and the area over Bastogne was probably the hottest combat environment in the world at the time. That is where Lieutenant Van Neiswender's sector was located. As usual, he was flying his assigned P-61 named *Daisy Mae*.

"I remember there was a full moon out, so the visibility would be very good. The first two hours of the mission were uneventful. But, so much for the boredom. We received a call from GCI informing us that there was an intruder coming into our bloc. We were vectored close enough to get him on our AI (Airborne Intercept Radar). As soon as we had a lock on him, the bogey did a quick half-roll and dived for the dark wooded area below. I pushed the throttle wide open and the chase was on! It was a fight that should have entered the record books. We stayed close, but not close enough to fire the guns. We were finally able to get a positive i.d. and it was an Me 410. This pilot had his airspeed over 400 mph and was pulling away quickly. I was wide open and it was as if we were standing still! Seconds later, we lost radar contact and at the same time, the tailcone at the rear of the crew nacelle caved in from the pressure. We had been up for over three hours and now we were headed back to Etain, with nothing to show!"

Very few photographs exist that show a transparent nose on a Black Widow, revealing all of its top-secret radar. The first nose-cones were Plexiglas, and normally frosted for security. This YP-61 named* Black Maria *was photographed in flight over California in 1944. Note that there are two people in the rear radar observer's station and that the aircraft has a two-gun turret.



The Me 410 was a replacement for the ageing Bf 110. Its speed was legendary and the specifications on the aircraft show that at an altitude of 22,000 ft (6705 m) it had a maximum speed of 388 mph (624 km/h). In the hands of an experienced pilot, the incident that Lieutenant Neiswender described could easily have happened. Chances are, the 410 pilot was red lining above 400 mph, which put him far beyond what the P-61 could do. Its speed was a safety valve that could get a good pilot out of a jam, especially at night.

For pilots in Europe during the treacherous winter weather, GCA (ground control approach) was a boon. This top secret package arrived at a small forward base in France, near Etain (A-82), in March 1945. The GCA operators did an outstanding job of bringing in aircraft on blind approaches in zero-zero weather. This new GCA system was a combination of radar and radio communications facilities. Two radar systems were used. One, searching a 30-mile (48-km) radius of the base, indicated the range, approximate altitude and the azimuth of any aircraft it encountered. The second unit scanned the area toward the landing end of the runway and fed back extremely accurate data for the final approach of the aircraft being tracked. It gave the final controller the ability to tell exactly how many feet an aircraft needed to adjust up or down, right or left to be on perfect track for touchdown. It has proven to be consistent in bringing every aircraft over the centreline of the runway at an altitude of 50 ft.

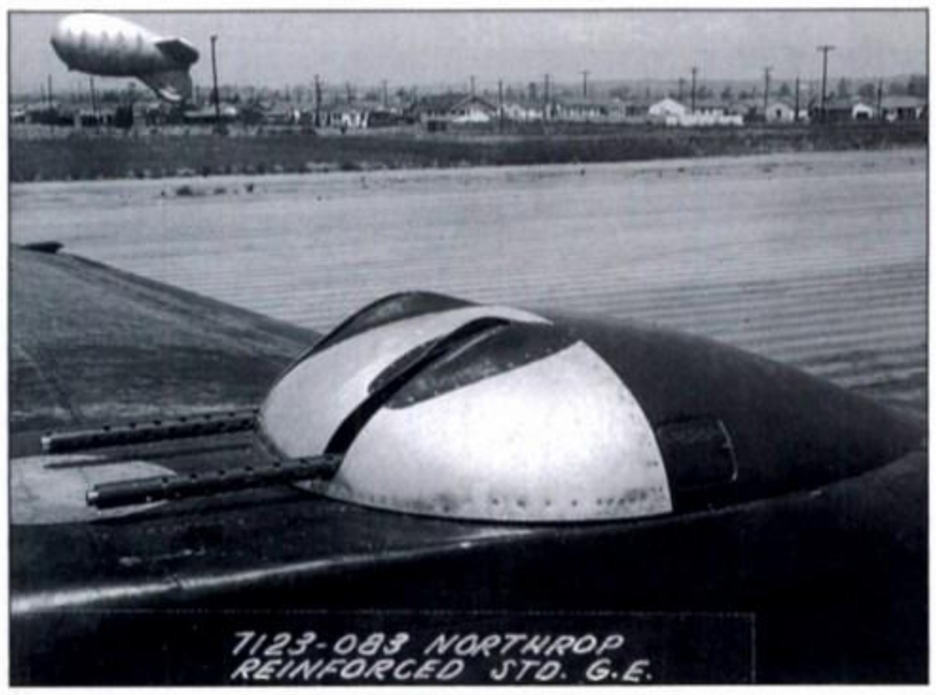
As soon as the new unit had arrived at Etain, it was put to work with some returning P-61s from the 425th NFS. While a pair of Black Widows was finishing its patrol, the ceiling was dropping around Etain, to between 0 and 200 ft (60 m). By the time the P-61s were on approach to the base, it was zero-zero.

Controlled approach

The tower, using the standard SCR-575 homer, had vectored the two ships on a straight path, 30 miles (48 km) out, at which point GCA took over. The operators gave precise landing instructions with additional vectors as the aircraft got closer, ensuring that the P-61s were steered clear of the heavy AA zones on the perimeters. At a certain point, the first ship was brought into the traffic pattern, while the second was put in a holding pattern. When the first P-61 was at 7 miles (11 km), GCA put it into a final approach in complete alignment with the runway; at this time, the 'precision' scopes kicked in and began to track anything within 10 miles (16 km) of the base. The operator, using these scopes, then gave altitude and azimuth corrections. At the 4-mile (6.5-km) marker, the lead P-61 began to descend at 130 mph (210 km/h) and 500 ft (152 m) per minute. Seconds later, it broke out of the overcast at an altitude of 50 ft (15 m), allowing the pilot to take over. The alignment was perfect and little or no corrections were

Turret Troubles

The original domed gun turret design was altered when wind-tunnel tests showed it caused buffeting. Unfortunately, it was not until after delivery of the YP-61s that it was found that the new teardrop-shaped unit suffered from equally severe buffeting when rotated. The turret was the sole defensive armament for the P-61, and although combat experience was to prove that defensive guns were rarely needed, intense effort was expended in rectifying this problem. With the pressures of the production schedule, Northrop engineers were forced to admit temporary defeat, and about half of the total production run was delivered without the turret.



In order to reduce the vibration created by firing four 0.50-in guns, a rare two-gun configuration underwent limited testing in the XP-61. The unusual turret shape was also part of the buffeting tests.

Several configurations were tested in attempts to reduce airframe vibration. Seen (right) in the wind tunnel and (above) on a P-61 are versions of a laminated wooden 'hat' that was attached to the rounded, domed turret. These designs, which caused drag and had a tendency to fly off in flight, were rejected.

With no immediate solution to the turret problems, production had to continue without it. This view, from the official recognition photo series, gives a good idea of the P-61's changed silhouette. Deletion of the turret saved 1,600 lb (726 kg), but top speed was only increased by 3 mph (5 km/h).

needed. This procedure was repeated minutes later with the second ship, and the results were the same.

In the spring of 1945, all roads led to Berlin. The four night-fighter squadrons in the MTO were working their way up from the south. The 414th had put a detachment on German soil on 3 April, its aircraft housed at a captured German air base near Strossfeld. This same detachment had just served with the 422nd NFS at Florennes, Belgium, gaining an immense amount of combat experience in the P-61. Its headquarters would remain at Pontedera, Italy until mid-July. Operations from Strossfeld gave the squadron its chance to get into the history books and it wasted little time beginning forays into the heart of Germany. From 7 to 10 April, the squadron bagged four enemy aircraft: one Me 410, one Ju 88, one Ju 188 and one Ju 52.

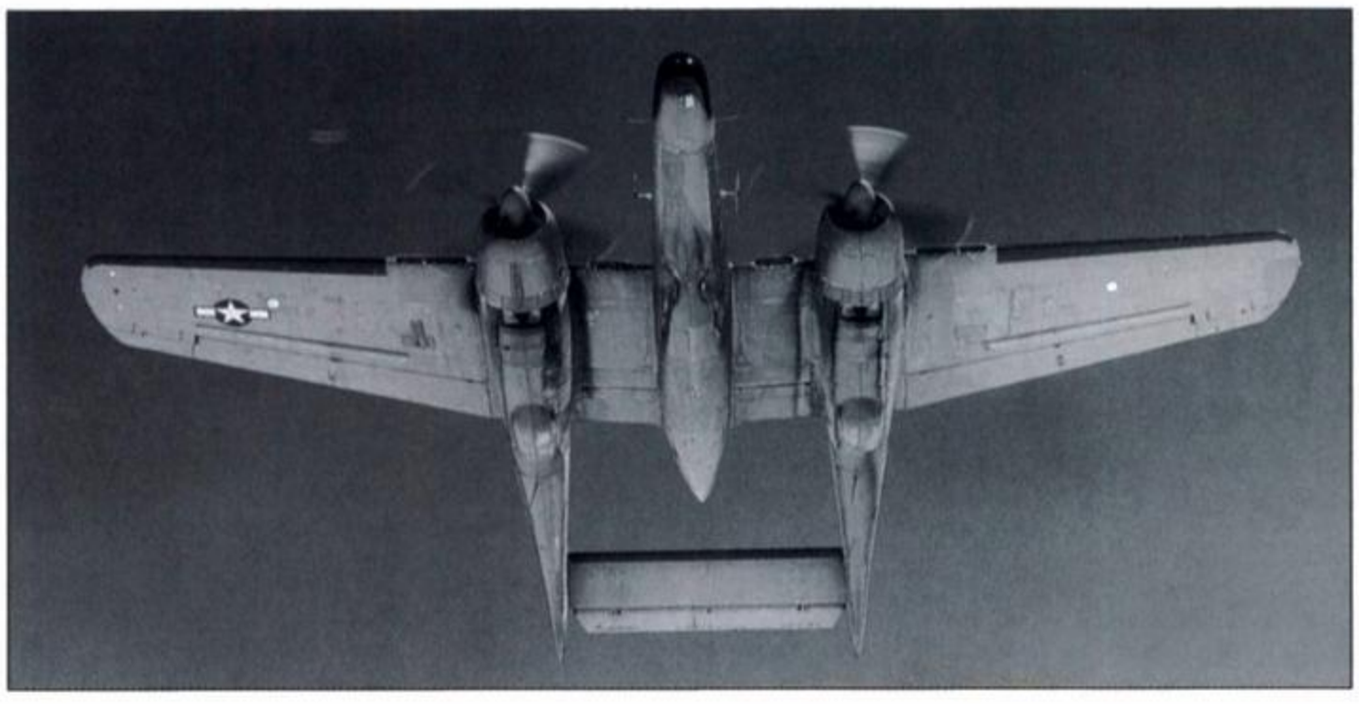
From the MTO to the ETO

The 415th, once it moved out of Italy, went through four quick stops at French bases between 1 September 1944 and 17 April 1945. At its last stop in France (St Dizier), it transitioned from the Beaufighter to the new P-61. By the time the squadron was proficient in the new night-fighters, it was time to move into Germany. On 17 April the 415th began combat operations from Gross-Gerau, which is where it was when the war ended. The opportunities for aerial combat at night had dried up before it received the P-61, so the squadron recorded no kills or damage credits against the Luftwaffe. However, its exploits in the Beaufighter had been exceptional and the 415th already had 11 kills and five probables when the Black Widow arrived.

The 416th NFS was probably the most unusual squadron to be included in the nocturnal arena. It began its combat tour flying the Beaufighters and in 1944 began to fly missions in the Mosquito; its tasking remained strictly at night. The 416th finished the war with five kills, four in the Beaufighter and one in the 'Mossie'. It did not work into the P-61 until the war was settled. However, some crews had used all three aircraft types before they rotated back to the US. Most of the fighter squadrons (day) that had fought in Europe had flown at least two fighter types, but it was exceptional for three types to be utilised in a speciality squadron such as the night-fighters. The 416th did not operate from German bases during the course of the war. Its base of operations from 27 March to 12 August 1945 was also Pontedera, and on 13 August it moved to Horsching, Austria, where most of its experience in the P-61 was gained.

The fourth and final AAF night-fighter squadron from the MTO was the 417th, which had come through bases in Algeria and Corsica in 1943. Its primary tool for combat was the Beaufighter. Having the good fortune to be in an area flush with German activity after dark, the 417th utilised the Beaufighter extensively. When it finally transitioned to the Black Widow, the squadron had been credited with nine kills, two probables and 15 damaged. By the time the 414th was considered for the P-61, it was already knocking on the door to Germany. The squadron began getting the new aircraft while at St Dizier, France and received the remainder of its Widows after the move into Giebelstadt, Germany on 24 April 1945. It would have made no difference to stay in the Beaufighter, as the

This is another recognition view of P-61A-5 42-5544. In the Pacific, some depots developed a fixed turret installation to replace the rotating turret; others utilised the turret cavity to add long-range fuel tanks.

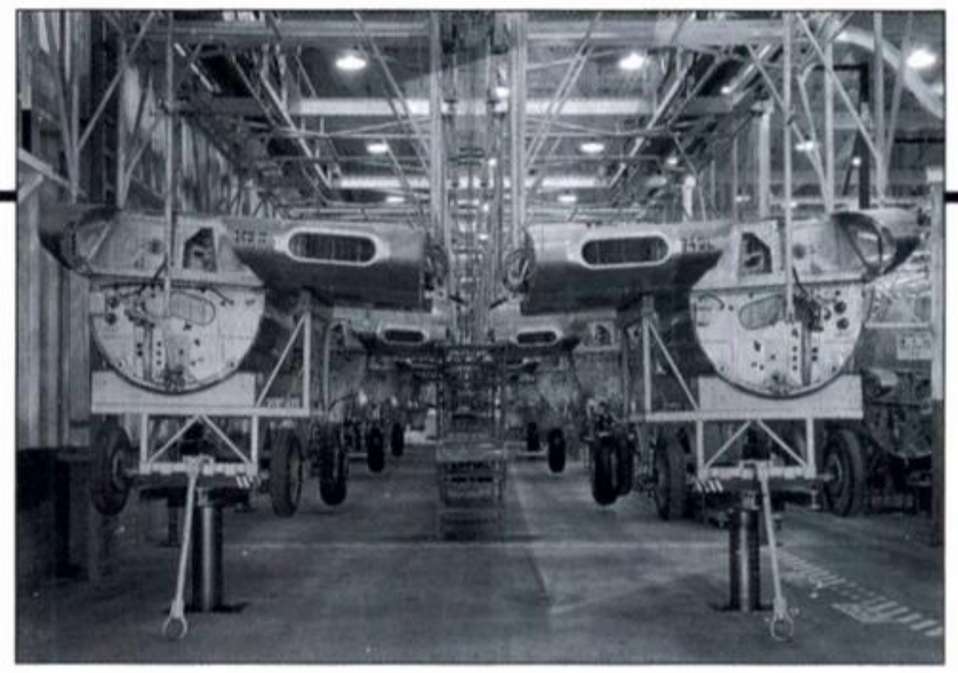


A new P-61A taxis back in after a test hop. The Northrop factory was built in an area that was encircled by civilian housing. As today's Hawthorne Regional Airport, it is under threat from developers who want to turn it into a shopping mall.

When the lead airframe on the assembly line stalled, the others ploughed into each other, doing extensive damage to the Plexiglas tailcones and radomes. Had the tail assemblies of these P-61Bs been in place, it would have been much more costly.

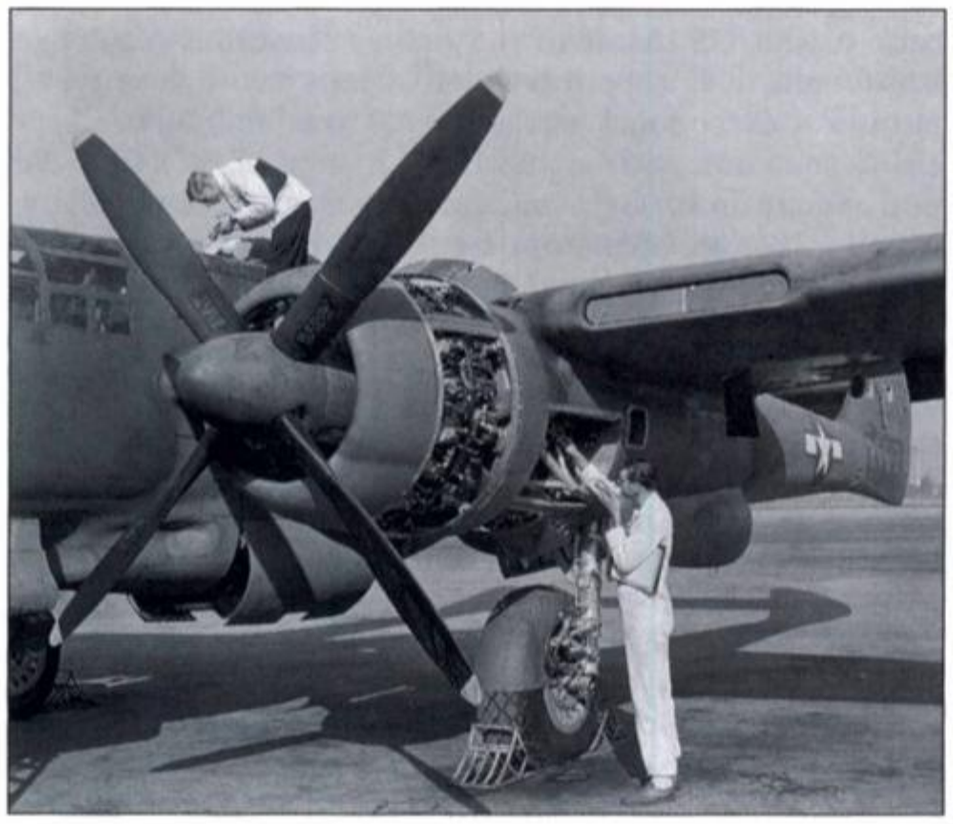
Building the Widow

All 742 production aircraft in the Black Widow and Reporter series were built at Northrop's Hawthorne plant, just south of today's Los Angeles International Airport. Modification of two airframes that began as P-61As to XP-61D standard was undertaken by Goodyear at Akron, Ohio, one of the Widow's major sub-contractors. Some 674 aircraft had been built by VJ-Day, at which time all contracts – a further 476 aircraft – were cancelled, but 36 partially completed P-61Cs were finished as F-15 Reporters.



This view was captured by Northrop photographer Roy Wolford on the final inner wing assembly line circa 1944. The nearest set has yet to have the landing gear attached.

Looking toward the southwest portion of the massive Northrop assembly plant, these P-61B models with their dorsal turrets are approaching the final stages of the process. The powerplants have already been installed in the engine nacelles and the props are being installed. Note the endless line of crew nacelles in various states of assembly in the background.



Northrop technicians execute a check list prior to a test flight by this early P-61A model. This Black Widow was the 28th P-61A-1-NO produced of a total of 45, and was in the first production run after the YP-61s were produced. These aircraft were finished in olive drab colour and many were used to outfit the 6th Night Fighter Squadron in the Pacific.

A new Black Widow receives routine maintenance by Northrop technicians prior to testing. Note the engineer using the radar operator's entry hatch.

existence of German intruders had all but disappeared; the squadron would not have seen action with any type of fighter. The 417th was very involved with occupation duties and worked from four German bases during this period.

The 'Green Bats' of the 422nd NFS made their final kill of the war on the night of 13 April 1945, when Lieutenant Ted Jones and his R/O Lieutenant Bill Adams destroyed a Ju 52. The squadron's final three kills of the war were Ju 52s, two going down on the night before Jones and Adams got theirs. These victories were credited while the squadron was operating from Strassfeldt, Germany. On 26 May it made its last 'wartime' move, to the big Luftwaffe base at Kassel. The war ended with the 422nd being the top-ranked night-fighter squadron in all theatres: its efforts led to an amazing record of 43 kills, five probables and five damaged. If the squadron had possessed enough P-61s during the Battle of the Bulge, it might have scored a significantly higher tally. Post-war time during the occupation was brief, and the 422nd was moved Stateside in late September 1945.

The 425th NFS did not move to Germany until 12 April 1945, when the squadron set up operations at Frankfurt-Main Aerodrome. This residence was short lived, as orders came for the unit to move to Furth, Germany on 2 May. The squadron's final kill score was 10 enemy aircraft. The 425th claimed four of the nine V-1 'Buzz Bombs' knocked down. Like the 422nd, its occupation time was fleeting, and it returned to the US on 9 September.

One fact about the ETO night-fighters stands out. If both ETO squadrons had been fully equipped with P-61s at all times, the final statistics would have impressed even the most humble of statisticians. Not only would the number of aerial kills have been significantly higher, but the marauding Black Widows would have exacted a toll of

hundreds of destroyed vehicles and thousands of German lives for road and rail traffic during the Battle of the Bulge. Any enemy moving after dark would have had a death wish. In event, the Germans – unmolested – were able to move forces and materiel over road and rail networks.

Marines over Europe

The Marines, fighting in the Pacific, had been involved in night-flying from the early days. They were using the Vega Ventura (PV-1, in Navy designation) at the same time the USAAF was putting up the Douglas P-70 against Japanese night intruders. On 25 July 1942, the Corps received authorisation to form its first night-fighter squadron (VMF(N)-531), which came into being on 1 January 1943 with a full complement of 12 aircraft.

Right after D-Day, the 422nd and 425th NFSs received enough P-61s to enter the battle. Shortly thereafter, they moved into recently captured bases in France. In late July 1944, one Marine night-fighter team was attached to both squadrons for combat experience in the Black Widow. The pilot was Lieutenant Colonel Martin A. Severson and his radar observer was Technical Sergeant James McGarry; they flew 12 missions and gained valuable experience in a very sophisticated night-fighter arena. Technical Sergeant McGarry recalls their first mission on 6 August 1944, flown with the 422nd NFS. According to McGarry's log book, they flew this mission in a/c 5565, *Double Trouble*.

"Our very first mission in France was from the airfield near St Mère Eglise. It was a patrol west of Cherbourg at 7,000 ft. The intent was to intercept Fw 200 transports thought to be evacuating German troops from the Guernsey and Jersey Islands. We were vectored by GCI to a possible bandit in this area. I picked up a radar contact on my SCR 720 set, at seven miles, and directed my pilot into a position behind and beneath at 10° port, 10° above. We closed to 300 ft.

"I advised Colonel Severson that we were at minimum radar range and if we got any closer I would lose the bogey on my screen. My face was buried in the extension tube on the screen when, out of the corner of my eye, I noticed something that looked like snow passing over the starboard side of our Black Widow. I called out on the intercom that it was snowing.

"Severson replied, 'Snow, hell! Those are tracers.'

"We just intercepted a British Stirling and the tail gunner has opened up on us! IFF did not function too well, between aircraft. The bomber was perfectly justified in shooting at us. We rolled over immediately into a diving departure. In a few moments, we notified GCI that the bogey was indeed a friendly. With the possibility of having taken some hits in the starboard engine, we made an emergency landing at a small unmarked airfield where we had the engine checked out. No hits, so we finished our business and returned to base."

Of the 12 missions flown by the Marine aircrew, most were uneventful patrols. On their fifth mission, flying in a/c 5544 *Lady Gen*, they engaged a bogey; violent evasive action by the intruder caused them to lose AI contact several times. The bogey finally escaped untouched. Records show that the Marine night-fighter team reported to the 422nd NFS in late July and all their combat missions were flown in August. The last one was logged on 31 August 1944. The experience they took back to the Marine NF programme was invaluable. McGarry went right into the training programme for the new Grumman F7F Tigercat.

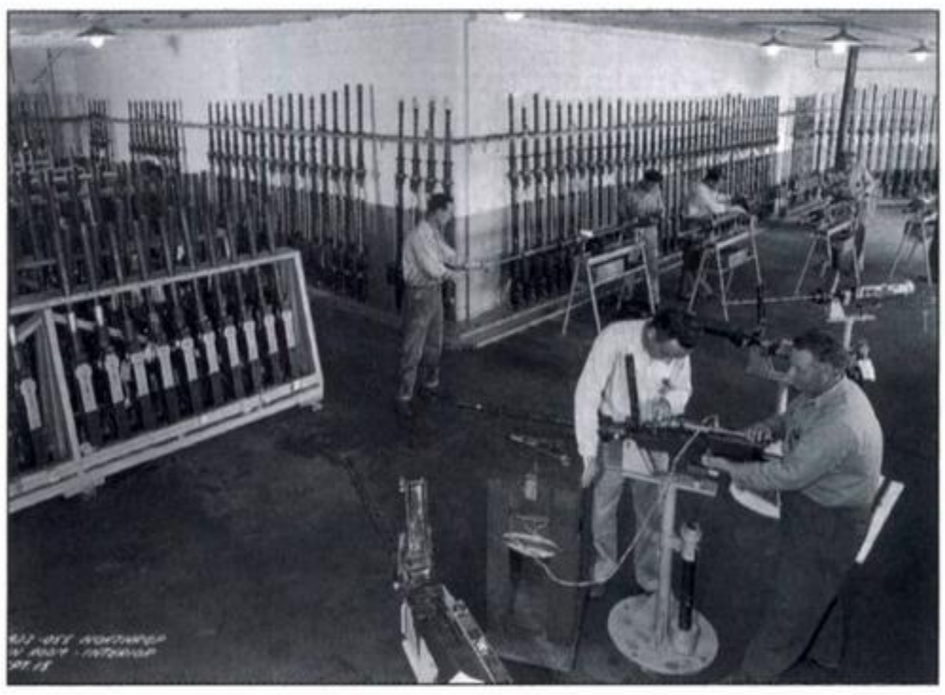
P-61 in the PTO

Two major factors put the Allied forces at a distinct disadvantage in the Pacific: the battlefield covered such a vast area that the only stepping stones left from which to begin shrinking the Japanese sphere of influence were Hawaii and Australia; and, the Japanese had plenty of time to secure and fortify all the major strategic islands. As the first US foothold on Guadalcanal was secured in late 1942, it became apparent that no matter which Japanese base the US decided to take, their ground forces would be exposed to night attacks from any of several air bases within striking distance by the Japanese air arms. Within days of the US Marines landing on Guadalcanal, it was evident that without proper protection at night, it would be a very long war. The night-fighter programme had not progressed enough to have the right aircraft ready at the right time; the P-61 was still a long way from becoming an operational reality, so a stopgap was needed.

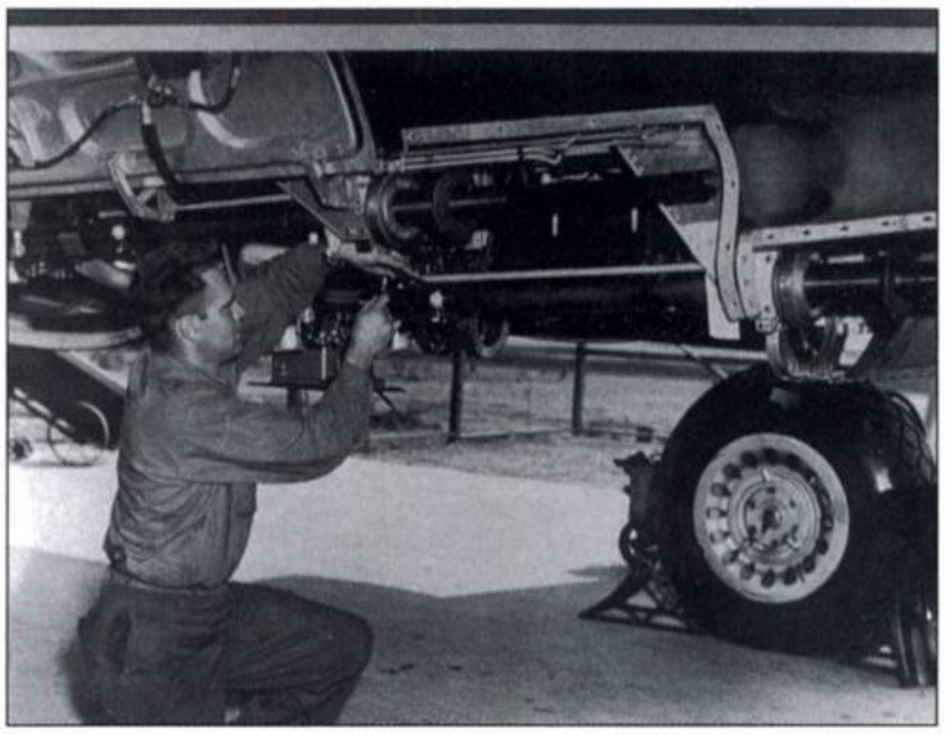
A variety of aircraft types was drafted into the role: B-25,

Above: New P-61A-10s line up next to the camouflaged final assembly area at Northrop. This particular model, of which 100 were built, saw more combat than any other Black Widow. There are more than enough P-61s in this picture to outfit an entire squadron. None of these aircraft has been fitted with the top turret.

Left: The difference in firepower is shown on these two P-61Bs produced within weeks of each other. Closest to the camera is a P-61B-6 (without top turret), participating in the lengthy and time-consuming process of producing the upgrades on the Operations Manual. Taxiing in the background is a new P-61B-15 with the top turret. P-61 42-39577 was the fifth Dash-15 built of a total of 153, all of which featured the turret that had been reintroduced into production with the P-61B-15.



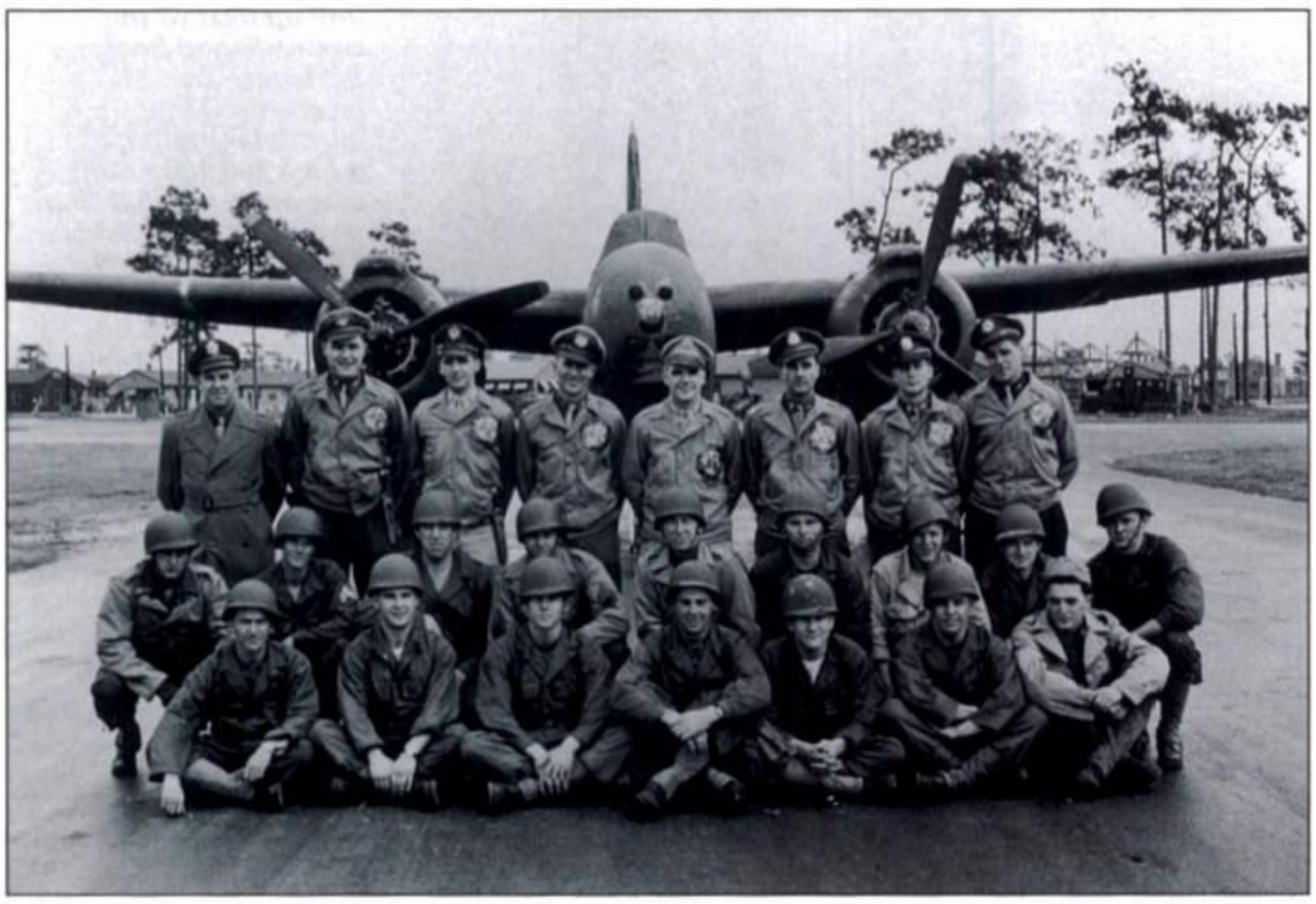
This was the Northrop gun room where all of the preparation of the 0.50-in and 20-mm armament for installation into the Black Widow was carried out. Both types of guns are shown here. In combat, the 20-mm cannon were almost flawless in dependability and effectiveness.



A Northrop technician makes some adjustments to the four 20-mm cannon located in the lower part of the crew nacelle. This photo was taken at the factory prior to a test firing session. Tests with the XP-61s found that firing the cannon caused extensive damage, as did the machine-guns. Several parts, including the nose gear doors, were replaced with steel items as a result.

Into service in Europe

After many months of training, the 422nd NFS aircrews departed Florida for England on 6 March 1944. At the time, they expected to be flying the P-70 Havoc, but hoped for the P-61, in which they had been the first NF squadron to have had (a little) training. For over two months after arrival at RAF Charmy Down, the 422nd had only an assortment of British aircraft with which to practise their skills, but finally, on 23 May, the first P-61 arrived at their first operational base, Scorton. A period of refresher training on their new mounts followed until, shortly after D-Day, they were declared operational.



The 422nd had just finished its advanced training and was ready to be shipped overseas to England. It was the last unit to finish its training in Florida, as the entire training organisation was moved to California's Hammer Field. C Flight, wearing suitably warlike headgear, is shown here at Orlando AAB in the spring of 1944 with one of the P-70s in which it had trained, shortly before heading for combat.

Below: Although the RAF had at one time ordered a large number of P-61s, only one was ever delivered to the British. A turreted P-61A-1 was the first Black Widow to arrive in the UK, in March 1944, and it was evaluated by the RAE at Boscombe Down and returned to the USAAF in February 1945.

P-40, P-38 and finally a specially modified version of the A-20 Havoc. It was called the P-70, and became the designated night-fighter to defend whatever land the Americans could secure in their efforts to turn the war around.

In May 1944, almost two years after the landing on Guadalcanal, the P-61 was finally making its way into the Pacific squadrons. The 6th Night-Fighter Squadron was the first to receive them and, at the time, it was stationed at John Rodgers Airport in Hawaii. The initial shipment of Black Widows included P-61As in the olive drab finish. They also had the top turret, which meant that the gunners would be able to make the most of their skills. The two detachments of P-70s sent by the 6th to New Guinea and Guadalcanal had been brought back to Hawaii in mid-December 1943. The 6th was also the only night-fighter squadron that the AAF had in place from almost the beginning of the war; it had been stationed in Hawaii as a day-fighter squadron when the Japanese bombed Pearl Harbor.

The long-range planners for the Pacific Theatre had anticipated the need for several night-fighter squadrons, all of which were formed with the Black Widow in mind. The first two were both activated on 1 April 1943, the 418th and 419th NFSs. Both units had been shoved into combat before the Black Widow was ready to become operational and had flown the P-38, B-25 and P-70s in the role. The arrival of P-61s meant that the high-flying Mitsubishi G4M 'Betty' bombers would no longer be out of harm's way. The 419th was the first of the two to receive P-61s, from 3 May 1944; the 418th did not begin the transition until September. One other squadron, the 421st, which had not been activated until 1 May 1943, got its Widows on 1 June 1944.

It would be impossible to determine whether Japanese Intelligence was aware of the P-61's arrival in the forward areas. Most P-61s came through the Hawaiian Islands, so they probably were noticed by Japanese agents, who perhaps did not recognise the type.

Despite its large size, the P-61 broke down relatively conveniently for shipping. These P-61As were deck cargo on a freighter bound for Liverpool. On arrival, they were taken to Speke airfield for reassembly and flight testing.

One of the first P-61As to arrive in the UK is seen at the 422nd NFS base at Scorton. It would seem that the ground equipment followed later, hence the rather excessive ladder.

Wacky Wabbit ***of the 422nd NFS went through a number of incarnations. The number of fingers held up by Bugs Bunny is said to have been doubled, making a 'V' for Victory, after complaints from the authorities. The nose of*** **Wacky Wabbit** ***(with single digit raised) reappeared on*** **Moonlight Wreck Wizishun,** ***a P-61 serving with the 418th NFS in the Pacific.***

Undercarriage
The wide-track tricycle undercarriage on the P-61 eased operations from rough strips at night. Nosegear collapses were not unknown, although they rarely caused major airframe damage. The hydraulically-retracted nose and main landing gear was manufactured by Bendix with Goodyear brakes and tyres. Mudguards were seen on P-61s in all theatres.

Northrop P-61A-5 Black Widow 422nd NFS A-78 (Florennes) July 1944

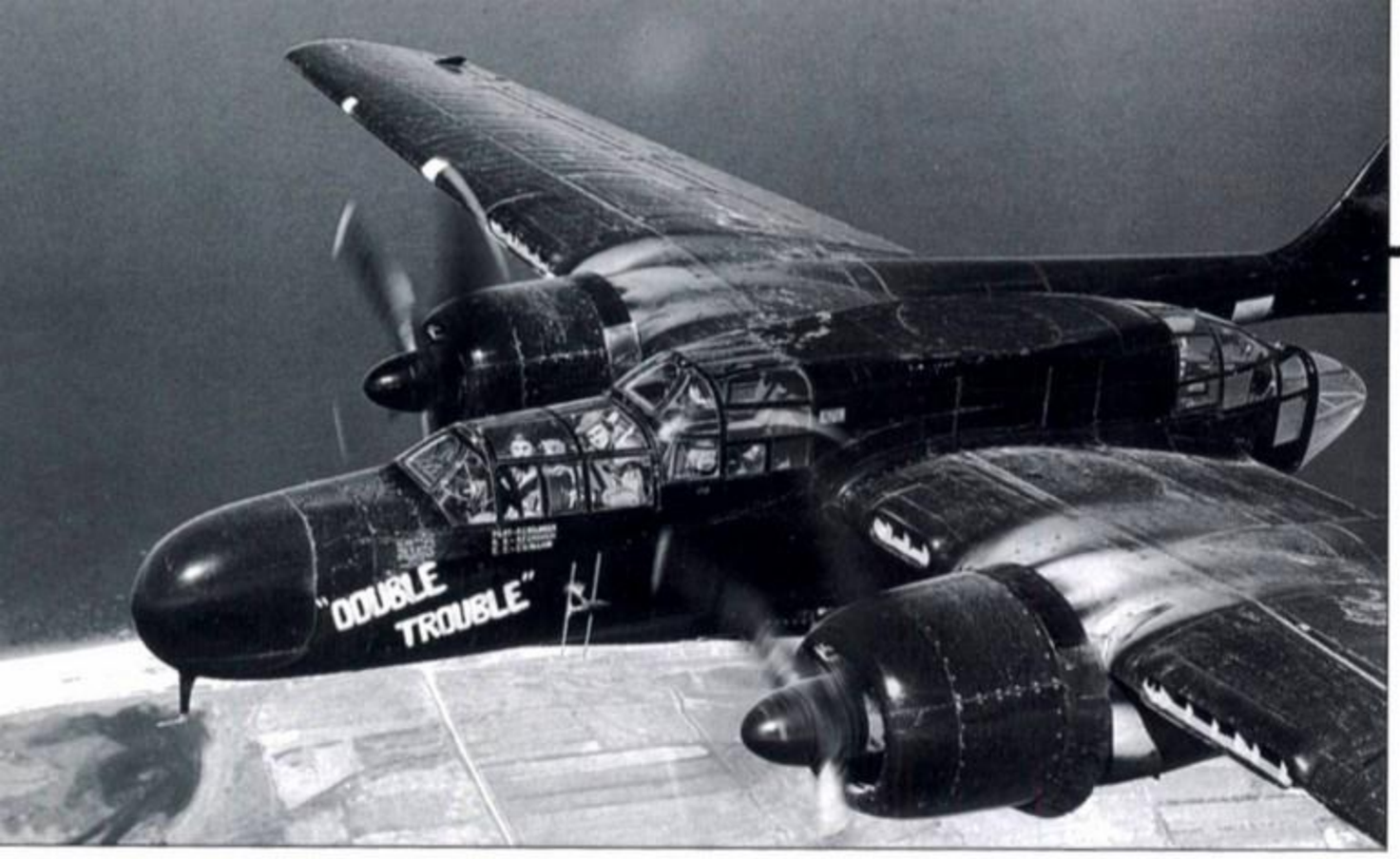
Invasion stripes
It has been said that only the 425th NFS had the distinctive black-and-white 'invasion stripes' on its P-61s, but they were used by both squadrons in the ETO in June 1944. Neither, however, was operational until after D-Day. P-61s in the UK on 6 June 1944 were given stripes, as were all tactical aircraft. Operational aircraft were most commonly seen with the topside stripes removed, as became general practice after 6 July.

This P-61A (42-5547) is typical of early arrivals in the European Theatre in that it was painted in the original olive drab/neutral grey scheme and was without the top turret. *Borrowed Time* was assigned to 422nd NFS ace Herman Ernst, although, in the ETO, crews tended to fly whatever aircraft were available.

Borrowed Time
This aircraft was responsible for only one credited victory, that of Gordon and Morrison, who destroyed a Ju 188 on 25 September 1944 while flying from A-78 (Florennes). The third crewman aboard at the time, T/Sgt Micuccio, was present as a flight engineer, there being no gunner assigned to 422nd NFS Widows, and he was not credited with the kill.

422nd NFS in the ETO
A 422nd detachment operated from Ford and then Hurn on anti-'Diver' patrols from late June 1944 until the move to the Continent on 26 July. The first base was Maupertus (A-15) on the Cotentin Peninsula, followed a month later by Chateaudun (A-39), and then Florennes (A-78), where the squadron remained from 16 September until the last days of the war, arriving at Strassfield, Germany (Y-59) on 6 April.

Night-fighter aces
Borrowed Time, with its Grim Reaper nose-art, was assigned to Lt Herman Ernst, whose regular radar operator was Lt Edward 'Mouse' Kopsel. This team scored the 422nd's first kill of the war when a V-1 was destroyed over the English Channel on 16 July. After the move to the Continent, Ernst and Kopsel scored victories over a Bf 110, a Ju 188, and no fewer than three Ju 87s, two of them caught just before daybreak on 2 March 1945 in *Tennessee Ridge Runner* (42-5543). This flight made the crew aces – in addition, they claimed a Bf 110 damaged on this date.



This close-up of the 422nd NFS's **Double Trouble** *shows to good advantage the extensive cockpit glazing of the P-61, beneath which another occupant appears to have squeezed. The 422nd's sister squadron, the 425th NFS, was instrumental in getting the radar operator's equipment moved into the former gunner's compartment. In addition to providing another pair of eyes looking forward, this change added 15-20 mph (24-32 km/h) to the top speed by moving the centre of gravity forward and lowering the nose angle in flight.* **Double Trouble**, *with the name painted in red, was flying from Maupertus (A-15) in Normandy when photographed by Charles Brown in September 1944.*

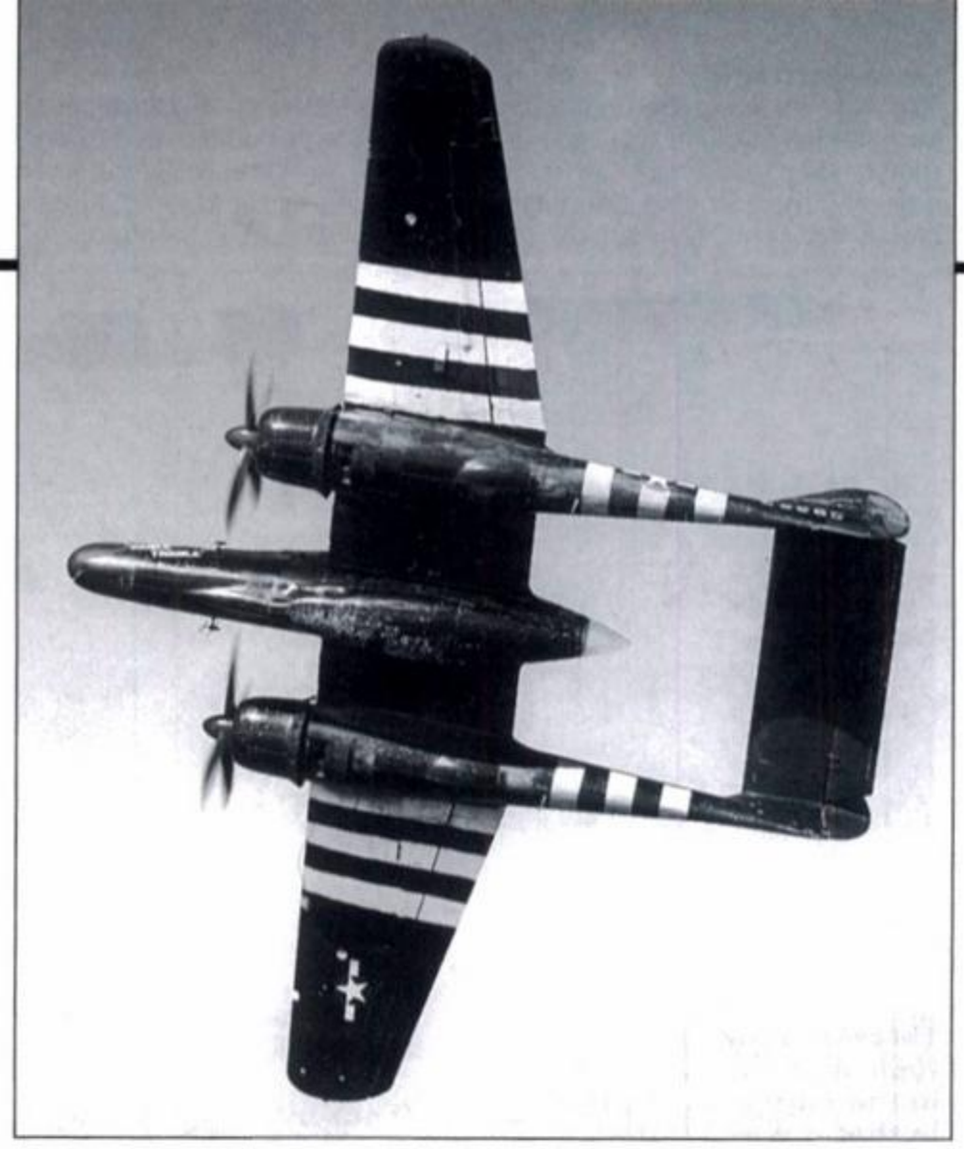
422nd Squadron commander Lt Col Oris B. Johnson (left) and his R/O, Lt James Montgomery, pose in front of their P-61A, **No Love! No Nothing!**. *Montgomery was the senior R/O in the squadron.*

Twilight encounter

During the P-61's combat time in the ETO, it was very rare to find any Fw 190s up at night. The Black Widow made only three Fw 190 kills, all credited to the 422nd NFS. One of the most interesting encounters came just before dark one day, shortly after 18.00. The 422nd's commander, Lt Col Oris Johnson, and his R/O, Captain James Montgomery, were patrolling in their assigned aircraft *No Love! No Nothing!*.

At 18.05, GCI radioed that they had picked up multiple bogies coming from the east, at 4,000 ft (1219 m); the squadron by then had moved to Belgium and was very close to German soil, so there was no telling what the Germans might throw up at night. Lieutenant Colonel Johnson, at his normal patrol altitude of 10,000 ft (3048 m), immediately responded to the call and went down to investigate. No aircraft were spotted, so Johnson returned to his regular position. Minutes later, GCI told him that they were picking up several more blips, this time at 5,000 ft (1524 m). Johnson quickly rolled over and down to close on the intruder's location. This time it was the real thing: three Fw 190s, loaded with bombs, on a straight and level course, flying at 250 mph (402 km/h).

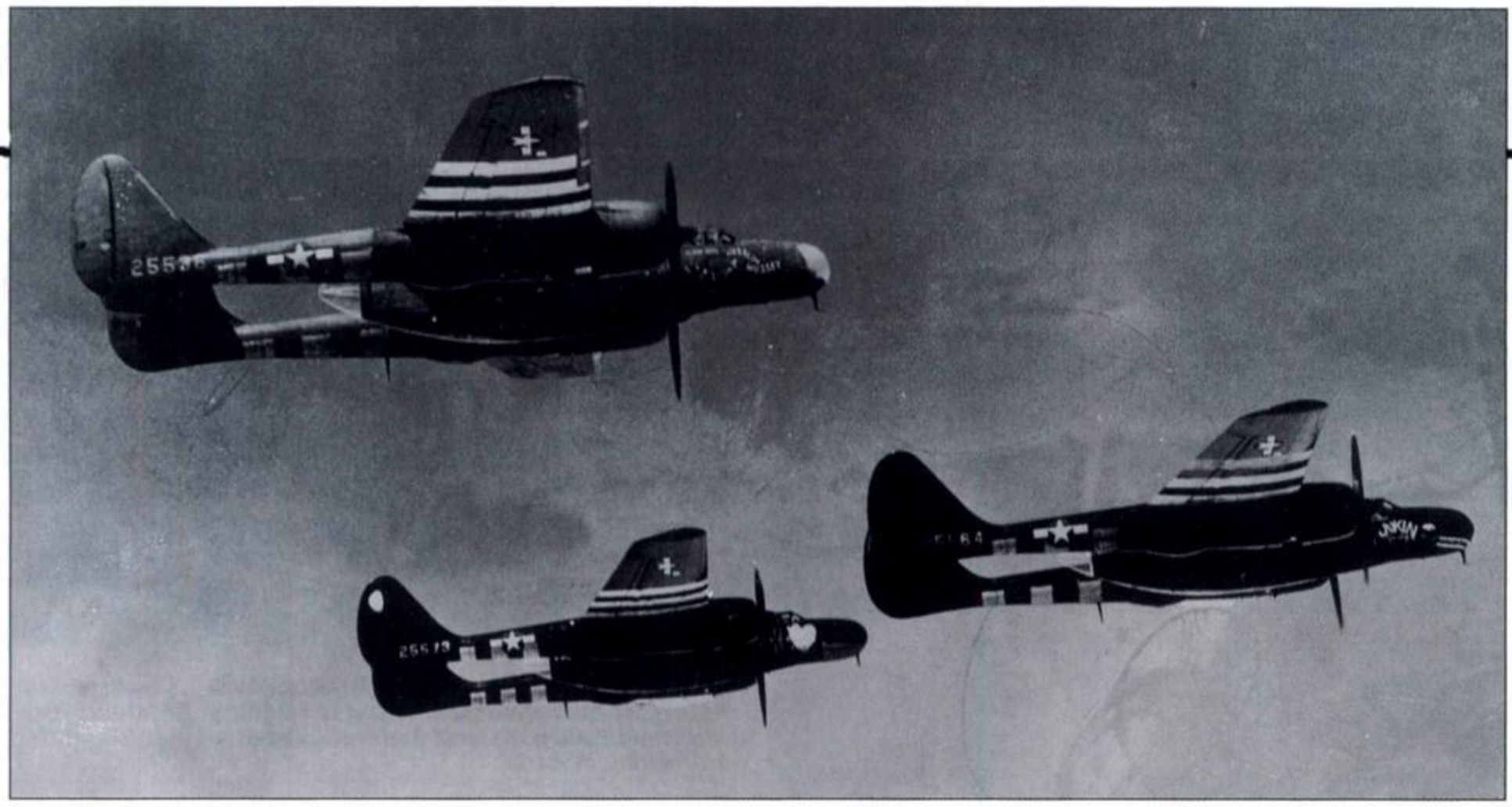
Wasting no time, Johnson headed into the middle of the formation, and as he got closer, the Germans saw him. Two of the Fw 190s broke off sharply, but the lead aircraft stayed on course. Johnson closed rapidly to about 1,000 ft (305 m) dead astern, putting his sights squarely on the intruder. Two short bursts of 20-mm fire found their mark, but were not fatal. The Fw 190 took the hits in its right wing and drifted into a slow turn to port. The range had narrowed to 500 ft (152 m), and the next five-second burst delivered the lethal punch. Hits were observed all over the fuselage, with black smoke pouring from the engine. The doomed German fighter-bomber nosed down into a near vertical dive and exploded upon impact with the ground. No parachute was seen. It had been a quick kill and the other two intruders had disappeared into the darkness.



Above: The painting of invasion stripes on such a distinctive form as the Black Widow was perhaps unnecessary, but orders were orders. **Double Trouble** *was the assigned aircraft of Lt Robert Bolinder, although he scored only one of his four kills in it.*

The aircrew of **Shoo Shoo Baby** *is seen here at a 422nd NFS base in France. On the right is pilot Captain Robert Elmore, with his R/O, Lt Leonard Mapes. An effective team, they ended the war with four confirmed kills.*

Little Audrey *was named for a nurse serving in France near the 422nd NFS's base. Here the real 'little Audrey' poses with her husband (left) in front of her namesake.*



Left: These three well-known P-61s of the 422nd NFS were captured in formation as they moved to the Continent in late July 1944. Between them, these Widows were credited with nine kills:* Jukin' Judy *(lead), four,* Lovely Lady *(far side), four,* and Husslin' Hussey *(in olive drab), one.

Ground crew unpack 20-mm cannon shells for loading into* Dangerous Dan *of the 425th NFS. The warload of a P-61A in the ETO on patrol or interception duties was 800 of these rounds.

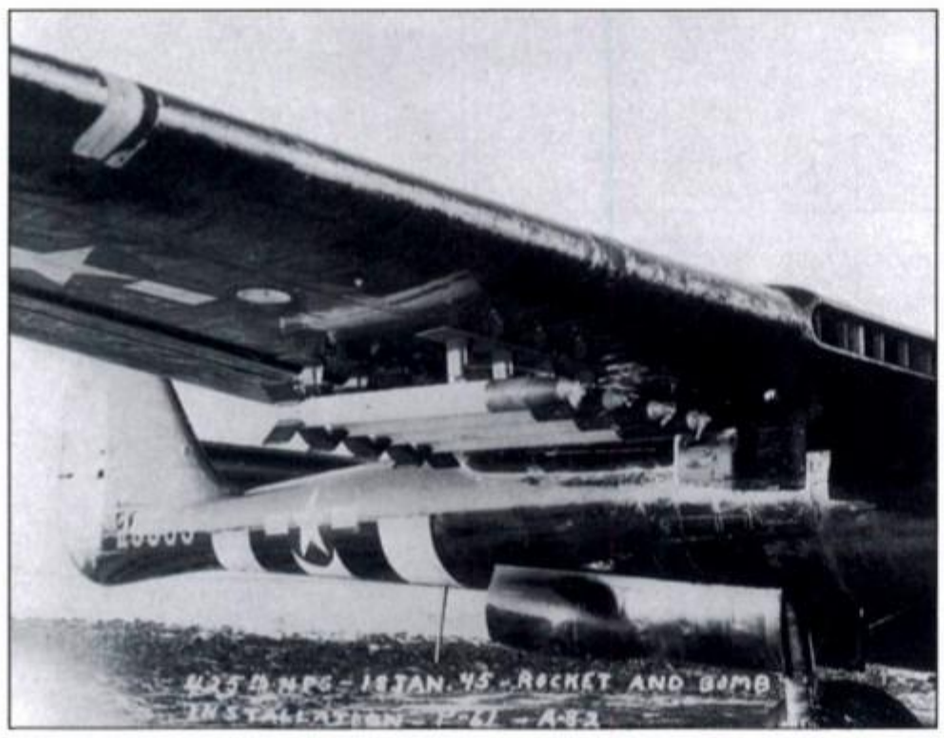
The 6th NFS was quick to draw blood. Lieutenant Dale Haberman and Flight Officer Raymond Mooney were on patrol during the night of 30 June. As usual, the Japanese tactic was to send a lone 'Betty' bomber at altitude higher than the operational capability of the P-70. Its target was the airfield on Saipan. GCI put the Black Widow behind the bogey and, in short order, Mooney had the blip on his scope. The closure was not unusual: very fast, with an easy visual identification of the enemy intruder. Dropping back to get the best firing angle, Haberman put a quick burst of 20-mm into the bomber and it exploded. There would have been no time for the stricken crew to send a radio transmission. This was the first of 16 kills recorded by the 6th NFS.

By 1 July 1944, the 421st was operating its new P-61s from bases at Nadzab, New Guinea and Wake Island, plus a couple of small detachments at more forward areas such as Owi Island. On the night of 7 July, First Lieutenant Owen Wolf and his R/O Lieutenant Byron Allain were standing strip alert on Owi. GCI picked up an incoming bogey and the crew was scrambled, but rain squalls meant that, after a few minutes, GCI lost contact. Wolf received permission to

It was difficult to find places for all of the Allied aircraft that had to be housed in France as the march to the east continued. The 425th found refuge in crude strips at Vannes and Coulommiers.* Tabitha *belonged to the 425th and its assigned pilot was Captain Hardin Ross.* Tabitha *crashed in the traffic pattern on 27 October 1944, killing Lt Bruce Hefling and F/O Bill Broach.

Above: As darkness falls, a P-61 awaits the call to begin its night's work. The Allies had air superiority by day, so the Luftwaffe sought the safety of night for hit-and-run attacks – but the Widows were waiting.

Right: The 425th took on a major role of night intruder work with its P-61s. This photo was taken in January 1945 and the invasion stripes are still visible. These Black Widows could handle a full load of rockets, as shown here, as well as 500-lb bombs.



P-61A-10 42-5580 gets some special treatment by 425th NFS ground crews. This photo was taken at A-58 (Coulommiers) airfield in France during autumn 1944.* Wabash Cannon Ball IV *was the Black Widow assigned to the squadron's commander, Major Leon Gilly Lewis.

remain in the area. After many minutes of heading in a westerly direction, a blip appeared on the scope at almost the maximum range of the radar. Closing the gap to about 6,500 ft (1981 m), Wolf throttled back to keep from over-shooting. Gradually, he came up behind and slightly below the enemy intruder. Finally, they were able to determine, by the unique exhaust pattern, that it was either a Mitsubishi Ki-21 'Sally' or Mitsubishi Ki-46 'Dinah' twin-engined bomber.

The bomber crew was unaware of being tracked at close

Lt Earl Dickey, right, senior R/O in the 416th NFS, poses with one of his fellow officers in front of* Midnight Passion. *This photo was taken at war's end while the 416th was based at Horsching, Austria.

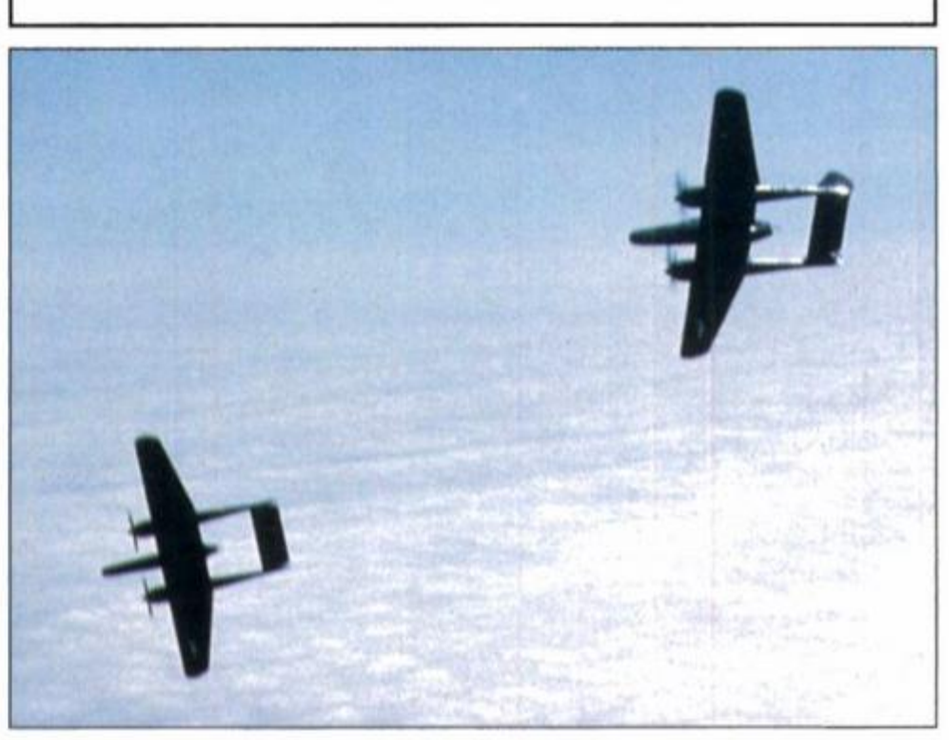
P-61 vs Me 262

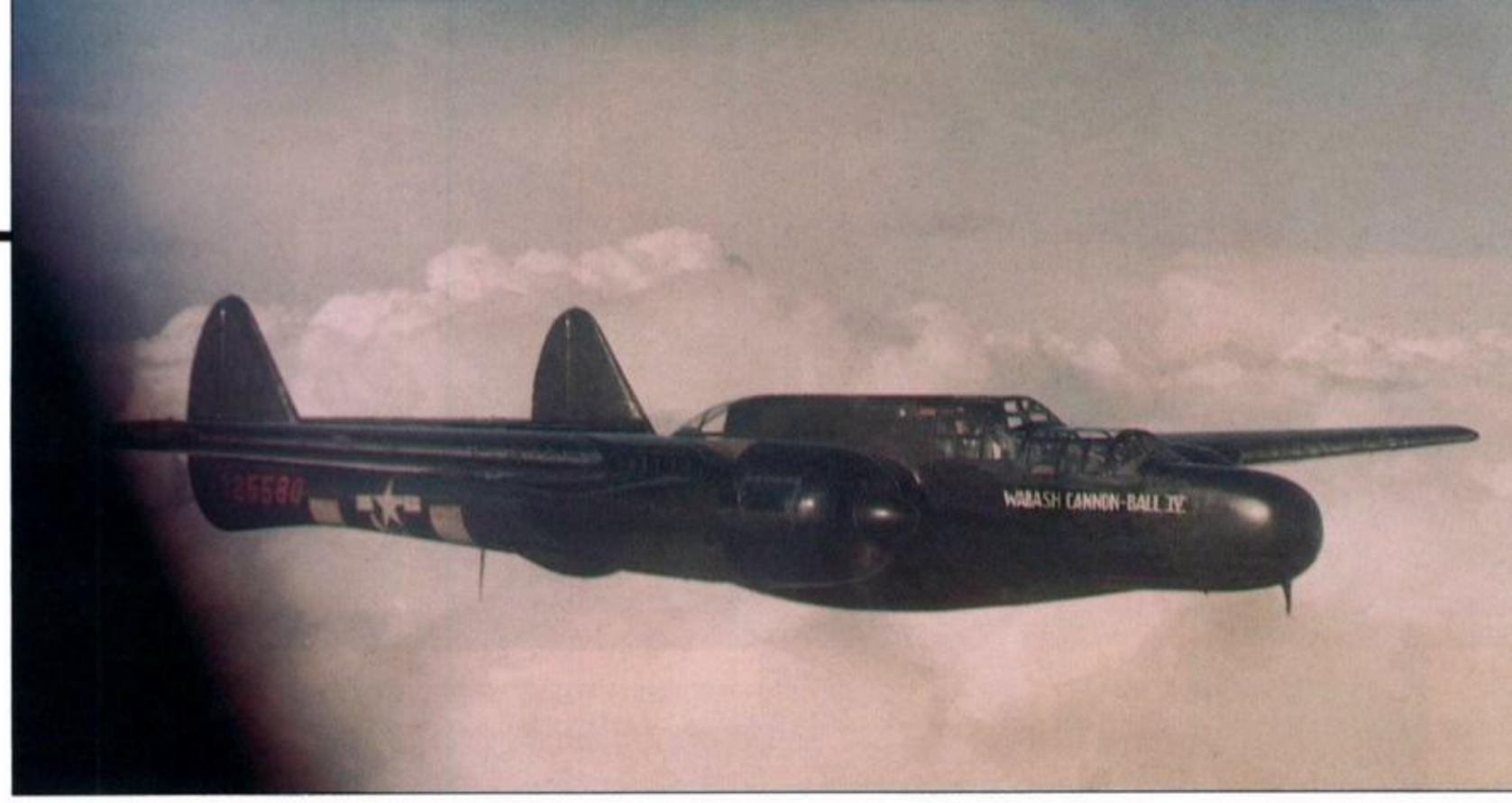
During the Battle of the Bulge, a 'feeding frenzy' over Belgium was brought about by the unusual number of German aircraft up at night. Lieutenant Earl R. Dickey, a senior R/O with the 416th NFS ('Mosquitos'), was lucky enough to have been sent to Dijon, France to support American night-fighter operations. While at this base, he flew several missions with the Black Widow-equipped 414th NFS, and came close to making the only night kill of a Me 262.

Dicket recalls the incident: "Late one night, we were vectored by GCI to intercept a bogey that was flying at a very high cruise speed and doing mild evasive turns. Obviously, the enemy pilot was not aware of any interception action. My target blip, both elevation and azimuth as well as range, was very clear as we turned in behind. We had to continually increase the power settings on our P-61 engines to keep from dropping behind. Finally, at absolute maximum cruise power, we were able to match the speed, but not better it!

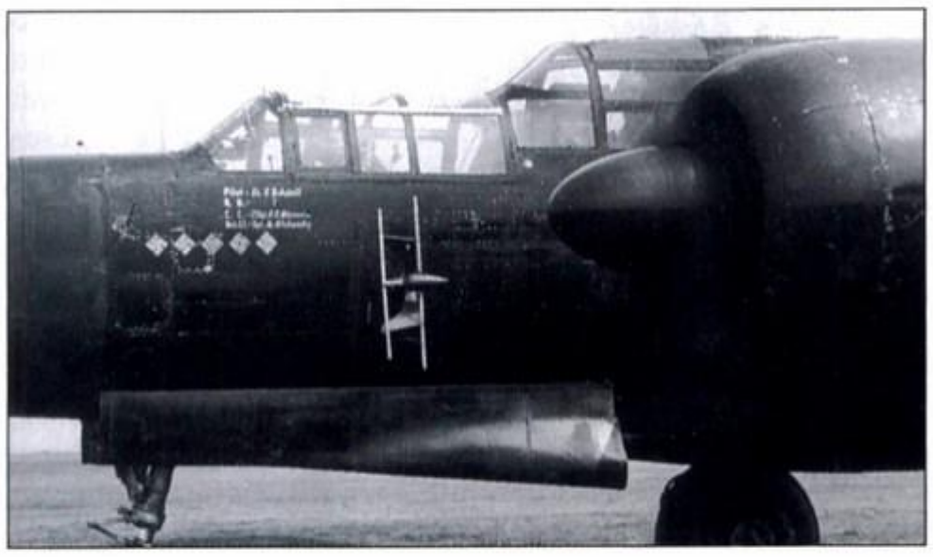
"After observing the casual, curving flight path of the intruder, I asked my pilot to take up a southerly heading and hold it, so we could close in on him by flying a straight path in the general direction he was headed. We were flying at a slightly higher altitude (approximately 10,000 ft) as I recall. Sure enough, we were able to slowly close on the bogey and still keep him from leaving the radar scope left and right. His altitude was fairly constant. We closed to within a mile without incident. The weather was hazy and he was not showing lights, so we had no visual at that distance and continued to gradually close successfully, with the GCI still tracking until we were within range of our 20-mm cannon. Still no visual identification. Just as we had agreed to fire on the aircraft without a visual, with GCI approval, we saw two bright lights pop on amazingly close in front of us! They were like two acetylene torches, as the afterburners *[sic]* were kicked on. At the same moment, the target left us like we were standing still. On my scope, it chandelled right and climbed out of range, off the scope. The two spouts of flame that we had observed disappeared out of sight.

"We were later informed that we had got close enough to trigger the early tail warning system thought to have been incorporated into the Me 262. This meant we had a good chance of hitting him with our 20-mm from the minimum range we had reached behind him. if only we'd had a few seconds more!"





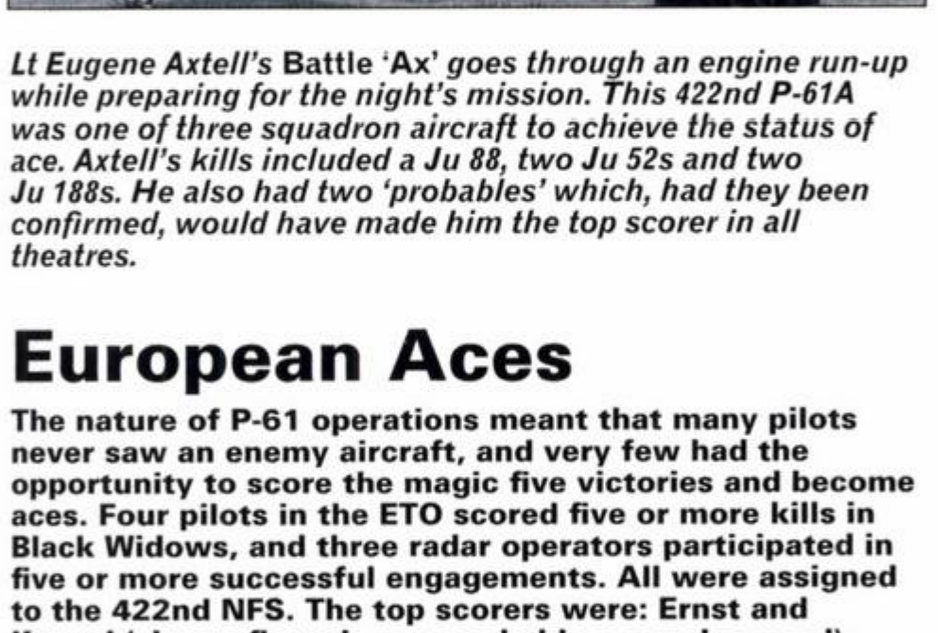
This is a classic example of why you should not fire on a V-1 'Buzz Bomb' at point-blank range. This aircraft was probably ETO night-fighter ace Lt Herman Ernst's **Borrowed Time.**



Lt Eugene Axtell's **Battle 'Ax'** *goes through an engine run-up while preparing for the night's mission. This 422nd P-61A was one of three squadron aircraft to achieve the status of ace. Axtell's kills included a Ju 88, two Ju 52s and two Ju 188s. He also had two 'probables' which, had they been confirmed, would have made him the top scorer in all theatres.*

European Aces

The nature of P-61 operations meant that many pilots never saw an enemy aircraft, and very few had the opportunity to score the magic five victories and become aces. Four pilots in the ETO scored five or more kills in Black Widows, and three radar operators participated in five or more successful engagements. All were assigned to the 422nd NFS. The top scorers were: Ernst and Kopsel (six confirmed, zero probables, one damaged); Smith and Tierney (five, one, zero); Axtell – with four different R/Os – (five, two, zero); and Elmore and Mapes (five, zero, zero). In addition, R/O Robert Graham was in on five kills and a probable, four of which (and the probable) were scored with Robert Bolinder as pilot.



422nd NFS ace Lt Paul A. Smith poses for the press in the cockpit of his **Lady Gen**, *at a forward base in France after the squadron had become involved in the close support and night interdiction role. At this point,* **Lady Gen** *had five aircraft, a V-1 and five locomotives to its credit.*

Above: **Wabash Cannon Ball IV** *is seen in flight over France a few weeks after D-Day. The aircraft's name came from a train that ran between Detroit and St Louis and inspired a country song with the same title.*

A future P-61 ace team poses in front of the blown-out rear Plexiglas cone of its **Black Widow, Borrowed Time.** *They were chasing a V-1 over the English Channel when it blew out, so loudly that Ernst could not hear his R/O. This photo was taken on 12 August 1944, when they had shot down one V-1. Pilot Lt Herman Ernst (left) and radar observer Lt Edward Kopsel became aces (five kills) with the high-scoring 422nd NFS.*

Lt Herman Ernst takes time out to have his picture taken with one of the squadron's enlisted types. This photo was taken in the early days before Ernst had made any kills other than the V-1 'Buzz Bomb' shown painted on the side of his P-61A. The combat camera can be seen at the base of the pitot tube support on the nose of his P-61.

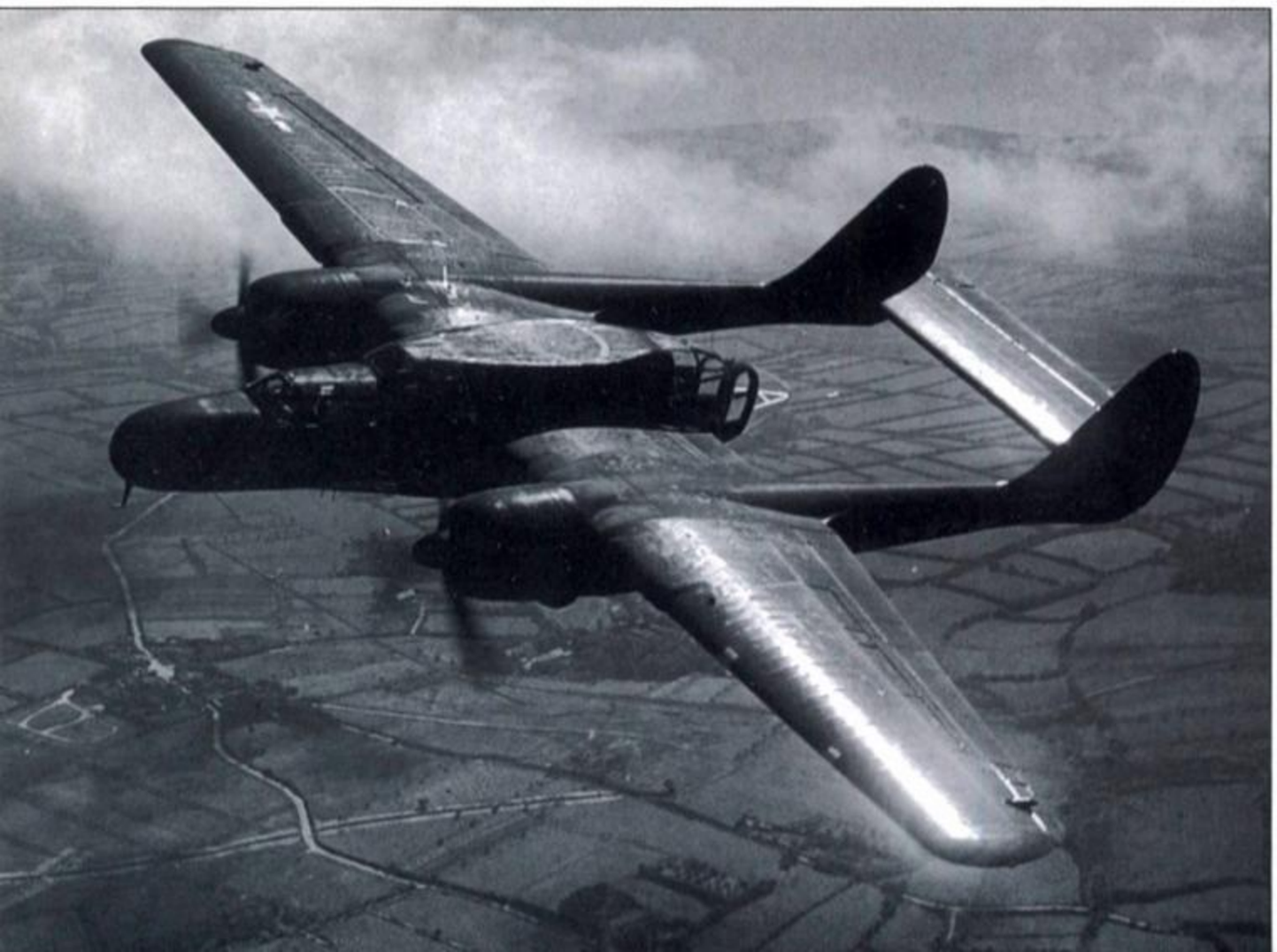
Above and top: Taken just days after the invasion of Normandy, these Black Widows and 'Mossies' have just received their D-Day stripes at a base in England. The P-61As were assigned to the 422nd NFS. In the background of the photograph above is* Borrowed Time, *the highest-scoring P-61 to fly in the ETO.

The sun glinting off a P-61A flying above the French countryside emphasises the flat top to the crew nacelle and the faired-over turret well. Also visible in this September 1944 view is an internal brace for the rear bubble, probably a field modification.

range. Wolf eased back the power and slid in behind until he felt he was at the right distance. For the first time, the firepower of all eight guns on the Widow would be employed: Allain fired the four 0.50-in guns and, at the same time, Wolf fired all four 20-mms. The stream of lead converged on the starboard engine of the enemy bomber. The engine burst into a ball of flame and part of the fuselage exploded, bits of which were thrown into the path of the P-61. Wolf continued to press the attack, for the bulk of the bomber was still in one piece. It trailed off into a bright orange fireball heading down into the ocean. Most, if not all, of the enemy crew were probably killed during the first long burst. Wolf commented that he had seen no return of fire from any of the bomber's guns. It had been an impressive, by-the-book kill.

After having achieved some moderate success with the B-25 at night, the 418th NFS was ready to receive its new P-61s in early September 1944. The squadron had proved to be quite a nuisance to the Japanese shipping around New Guinea, due to their low-level night attacks. At this early stage of conversion to the Black Widow, the 418th could have no idea that it would become the top-scoring P-61 squadron in the Pacific. When the war ended, it had 18 confirmed kills, followed closely by the 6th with 16 kills. The 418th was based at Morotai, Halmaheras, Netherlands East Indies from 28 September through 26 December 1944. In this 90-day spell, it made seven kills in the Widow.

Like many night-fighter squadrons in the Pacific, the 418th and 421st had detachments positioned to give maximum protection to bases housing valuable aircraft, such as on Tacloban airstrip in the Philippines. Captain Roland Fisher recounts the events when a Japanese commando unit tried to land at night, in a C-47 type transport. "This incident took place right after dark. I was acting as air control officer and we were beginning to receive some Marine Corsairs coming back in from a strike. In the middle of all this, it appeared that a cargo plane was in the pattern with his lights on. He radioed for instructions, in perfect English. As the plane passed over an alert anti-aircraft gunner, he noticed that although it appeared to be a C-47, the exhaust pattern was different. He fired a quick burst into the right engine. The pilot veered off course and was able to stabilise the aircraft, but as he came in, the plane was slightly off and parallel to the main strip. He ploughed into

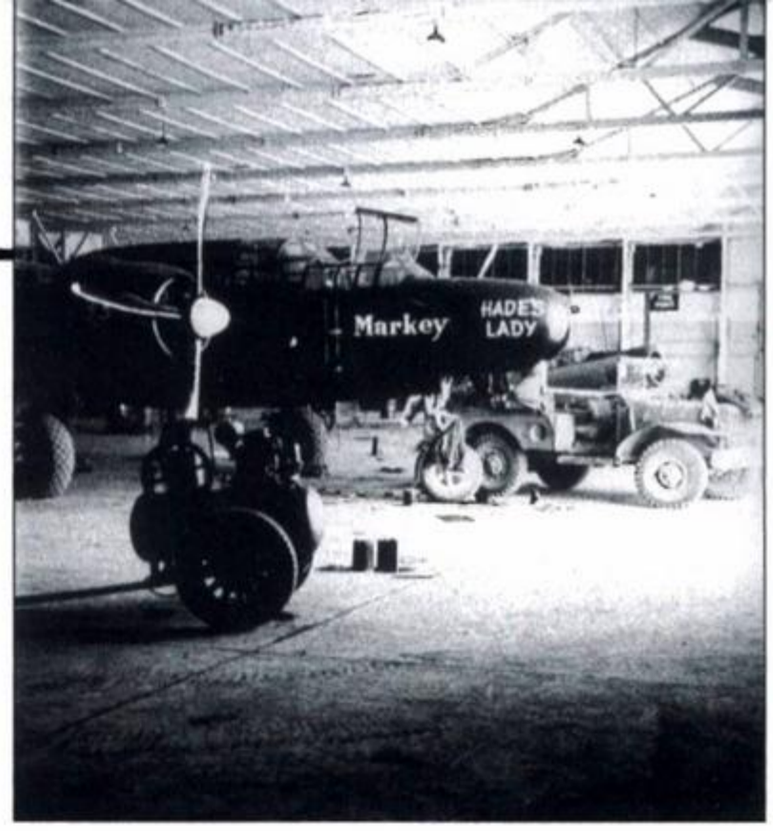


American actor Mickey Rooney gets some pointers on night fighter tactics from 422nd pilot Capt. Leonard F. Koehler. Notice that* Lady Gen *had been assigned to another pilot after Lt Paul Smith rotated out of the squadron. One of the kills shown was a probable and was eventually removed; the remainder of the credits are accurate. Chances are that this picture was taken after the Battle of the Bulge, so this is probably the squadron's base at Strassfeldt, Germany (Y-59).

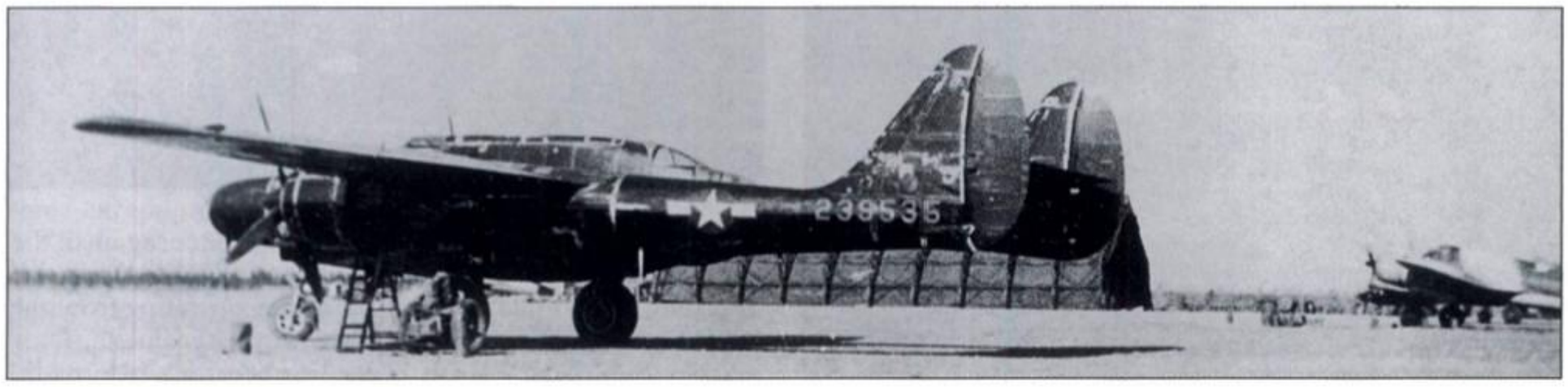
MTO

The Black Widow arrived in the Mediterranean Theatre after most of the night action had passed, and although the three squadrons that received the P-61 (the 414th, 415th and 417th NFSs) were experienced in combat with the Beaufighter and Mosquito, there were few successful P-61 combats in the MTO. The top-scoring crews in the MTO were Captain Al Jones and R/O John Rudovsky of the 414th NFS, with two kills. Only the 414th scored with the P-61. Not long after Italy's surrender, the 415th and 417th moved to France, and the 414th followed in early 1945.

Rudovsky (left) and Jones (right) of the 414th NFS pose with ground crew at a base in Italy.



Markey/Hade's Lady, *a P-61B-6 assigned to the 417th NFS, is seen in a former Luftwaffe hanger at Giebelstadt, Germany. The 417th was an early night-fighter squadron that spent most of its tour of duty in the MTO. The* **Hade's Lady** *name was given by a Northrop employee who won a contest as part of a War Bond drive.*



a row of parked Marine Corsairs. The Japanese transport exploded. spewing out burning troops all over the place. Those who survived the fiery crash were shot by the troops nearby. Had this landing been successful, it could have cost us many lives in the 421st. It was bad enough, however, because of the American lives it cost when they hit the Marine flight line. When dawn came, we were still trying to sift through the wreckage, hunting for wounded Americans."

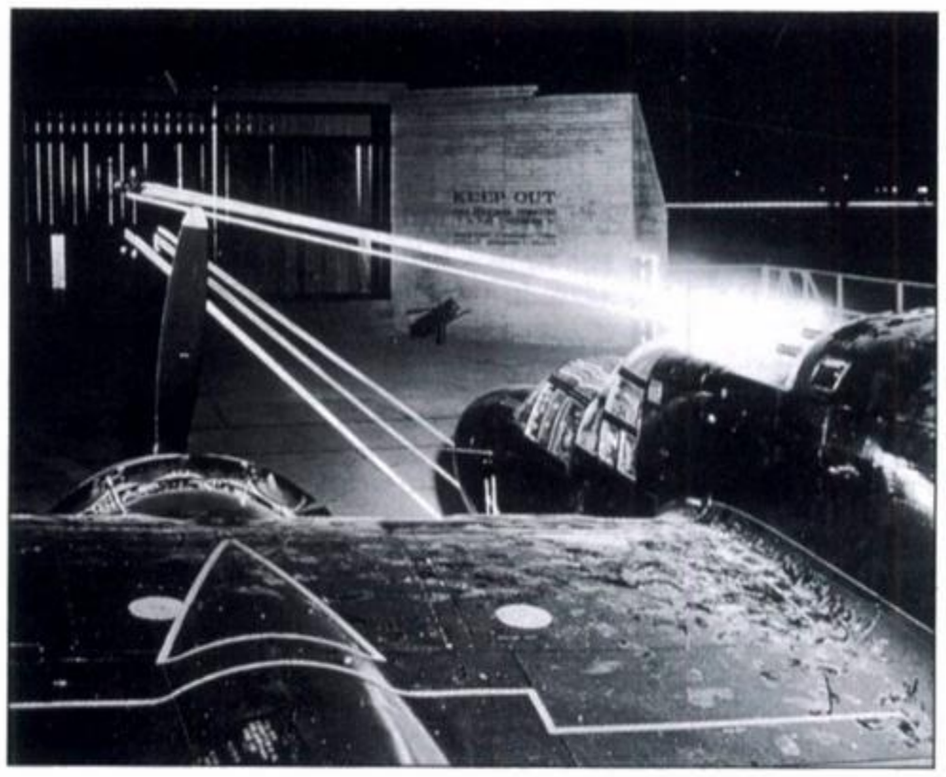
With the delivery of P-61s to the 418th NFS, four squadrons had still to finish training and receive their aircraft. In order, the 547th, 548th, 549th and 550th squadrons were activated one month apart, beginning on 1 May 1944. The 548th, however, received its Black Widows first, in early September 1944. The squadron had just settled in at Kipapa Gulch, Hawaii when its new aircraft began arriving. Being in close proximity to the seasoned 6th NFS, it received valuable instructions from that veteran unit. On 15 December, the 548th sent a detachment to help on Saipan; it was the first night-fighter unit to land on Iwo Jima, before the island had been secured completely (5 March 1945).

For reasons unknown, the 418th and 421st squadrons encountered an unusual Japanese fighter type between mid-November and December. When the B-29s began operating from Saipan for missions over Japan, the enemy fighter that inflicted more damage than any other was the

Above left: This was one of the first P-61s to arrive on the 417th flight line at Le Vallon airfield in southern France. Prior to the arrival of the new Northrop fighters, the squadron had flown Beaufighters, one of which is visible at right. 42-39535 was a P-61B-6-NO, of which 47 were built.

The 9th Air Force hit every airfield in Germany with all it had, and just about all the structures and aircraft in and around these bases were destroyed. However, the fields were widely used by the advancing Allied air forces. This P-61, parked at a captured Luftwaffe base during the final weeks of the war, belonged to either the 422nd or 425th NFS.

A posed picture which says it all. The war-weary crew chief of this 422nd NFS P-61A is Sgt Albert Wiederspiel of New York. His charge sports two kill markings and the name* Mildred *on the number one engine.



Above and far right: P-61s let rip into the stop butts with all eight guns. The 20-mm cannon were harmonised to converge at 300 yd (275 m) and the 0.50-in machine-guns at 600 yd (550 m). A pressure switch prevented the guns firing with the nose wheel on the ground.

Right: With almost full-span flaps, the P-61 had outstanding short-field capability for such a large aircraft. Here a P-61B on a test flight comes in over the rooftops at Hawthorne Field.

Kawasaki Ki-61 Hien 'Tony'. Its presence against the Superfortresses was felt in the skies over Japan during the day, but the two night-fighter squadrons operating from the Leyte area had numerous run-ins with them at night. During this period, the 418th bagged three in a single night, and the 421st got two on the night of 10 November. Official records place at least two 'Tony' units in the general area during that time: the 17th and 19th Sentai, both day-fighter outfits with very little reason to fly after dark.

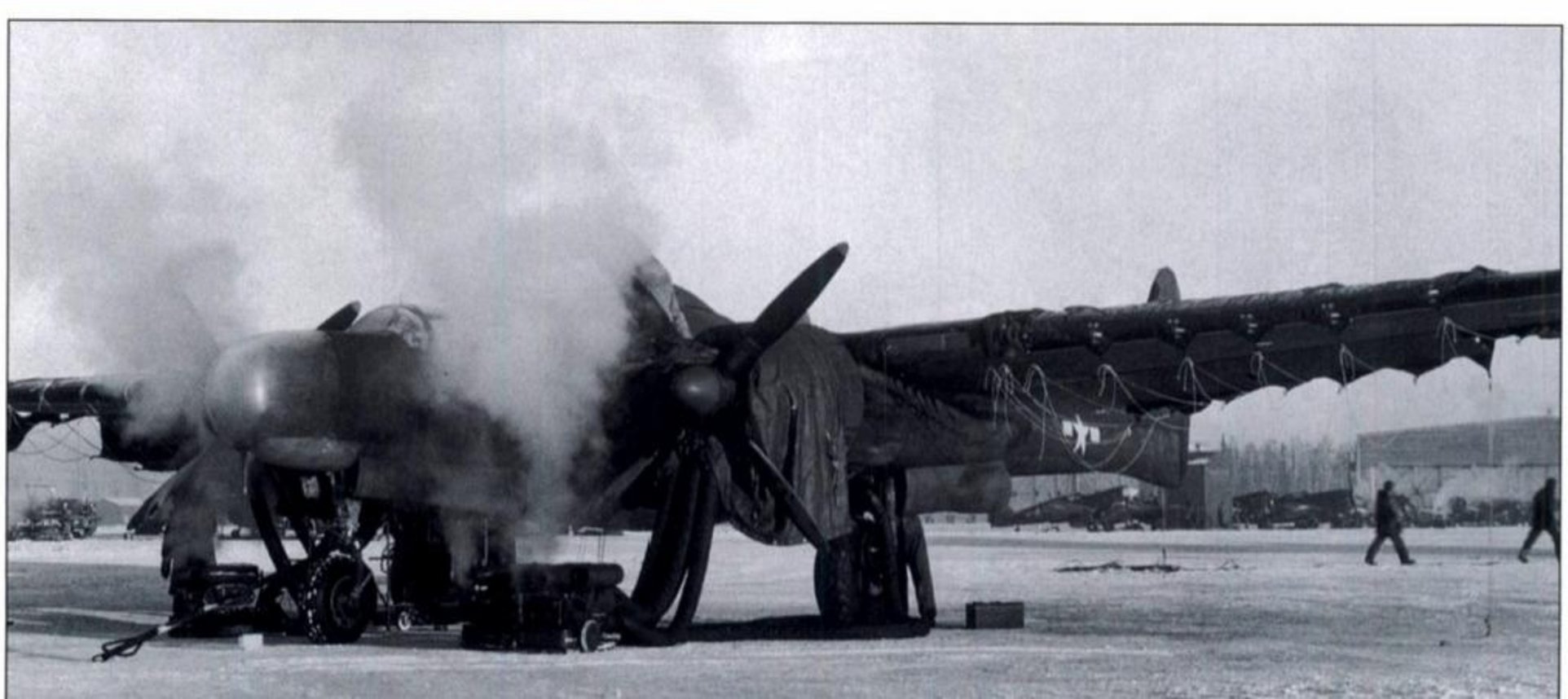
Three 'Tonys' in one night

The R/O on all three of the 'Tony' kills for the 418th, F/O Vincent Wertin, recalls a few details about the encounters with the Ki-61s, all of which went down on the night of 27/28 December 1944. "On the evening of 27 December, my pilot Lieutenant Malcolm Ritchie and I were working a shift from 18.15 to about 21.30. It was around Mindoro Island. At about 20.30, we were informed by GCI that there were several bogies in the area and we were vectored in on the closest one.

"At 4.5 miles, I locked on and brought us to within 3,000 ft, at which time the Japanese intruder make a very hard turn to port and disappeared off my screen! After some exceptional evasive action, we were once again 2,500 ft behind him and got a visual. It was one of those fast Japanese fighters identified as a 'Tony'. Moving up to within 300 ft, Ritchie opened fire with a short burst. We had hits but nothing happened. We moved up to within 5 ft of its tail.

Very few, if any, aircraft made it into the US inventory without undergoing arctic weather testing. The P-61 was no different. During World War II, no test hangers were capable of taking the temperature below 0°C (32°F), so testing was done in the real environment. In February 1944, this P-61A underwent tests at Ladd AAB, Alaska. New portable heaters were used to start the engines in temperatures of -35°C (-37°F).

After the war's end, when the P-61s were assigned to occupation duties, the squadrons took to adding a little colour to their charges. This 416th NFS Widow, seen at Horsching, Austria in September 1945, even has whitewall tyres to complete the sports car effect.



P-61B

The worsening war situation had forced production of the P-61A to be accelerated before all the deficiencies of the YP-61s had been addressed. Northrop soon began work on an improved version, which also took account of field experience with the P-61A. Most of the changes were internal and, with no solution to the turret problems, early P-61Bs came out of the factory looking very much like most As. The main changes were an upgraded SCR-720C radar, and an 8-in (203-mm) nose extension. One of the few immediately visible differences was a taxiing lamp on the nose gear strut.

Right: Northrop test pilot Alex Papana prepares for a flight in a new P-61B. This gunner's-eye view was taken in 1944, when the mass production of B models was in full swing.

Ritchie pulled up sharply, made a quick turn and came in behind at a safe range. We fired a longer burst this time and our 20-mm impacted dead centre. The 'Tony' exploded and went down in flames. The enemy pilot had displayed some exceptional evasive manoeuvring!

"Early the next morning, we repeated the same scenario, only with a different pilot, Lieutenant Bertram Tompkins. Again the 'Tony' gave us a hard time with violent evasive action, but it was to no avail. We finally locked on, hitting him with a long burst, and again the enemy fighter exploded right in front of us."

When January 1945 rolled around, the 6th NFS was back in Hawaii at Kipapa Field. It had just returned from some heavy combat in the Marianas (Saipan), and still had a detachment there. It was from this base that the squadron scored most of its kills. It downed three more Japanese aircraft during January. All of their kills in the P-61 were 'Betty' bombers. The 6th took out two more 'Bettys' on 1 and 2 January. Also on 2 January, the string of 'Bettys' was broken when F/O John J. Szpila shot down a Yokosuka P1Y 'Frances', bringing total kills in the Widow to 14. The squadron's next venture into harm's way would be a detachment sent into the volcanic hell-hole of Iwo Jima.

43-8327, the first of 84 P-61B-20s, eases off the Hawthorne runway. The B-20 was the last production B model, the B-25 block consisting of aircraft from earlier blocks that were modified with a mechanically-linked turret and radar.

The 418th had effectively moved several detachments to crucial air strips, protecting Army troops in New Guinea. On 26 December 1944, it moved its HQ to San Jose, Mindoro, Philippines. Their forays deep into enemy-held areas were legendary. Of the 18 kills the squadron confirmed in the Black Widow, six were made after 1 January. They began the new year with Lieutenant Albert Sorbo and his R/O, Lieutenant George Kerstetter, teaming up to take out two Aichi E13A 'Jakes' on the night of 4 January and an Aichi D3A 'Val' the following night.

Below: The addition of racks for external fuel tanks from late P-61As addressed one of the Widow's few failings – inadequate range. With four 310-US gal (1173-litre) drop tanks, as carried here, the range of the P-61 was increased by about 400 miles (644 km), but the take-off performance became marginal and the service ceiling was reduced to 8,000 ft (2440 m). It was recommended that a full load of tanks be used "only in an emergency".

Above: This YP-61 was used to teach the aircrews of the 426th NFS at Hammer Field, sometime in 1944. Just a few weeks later, the squadron was on its way to Madhaiganj, India and the CBI Theatre.

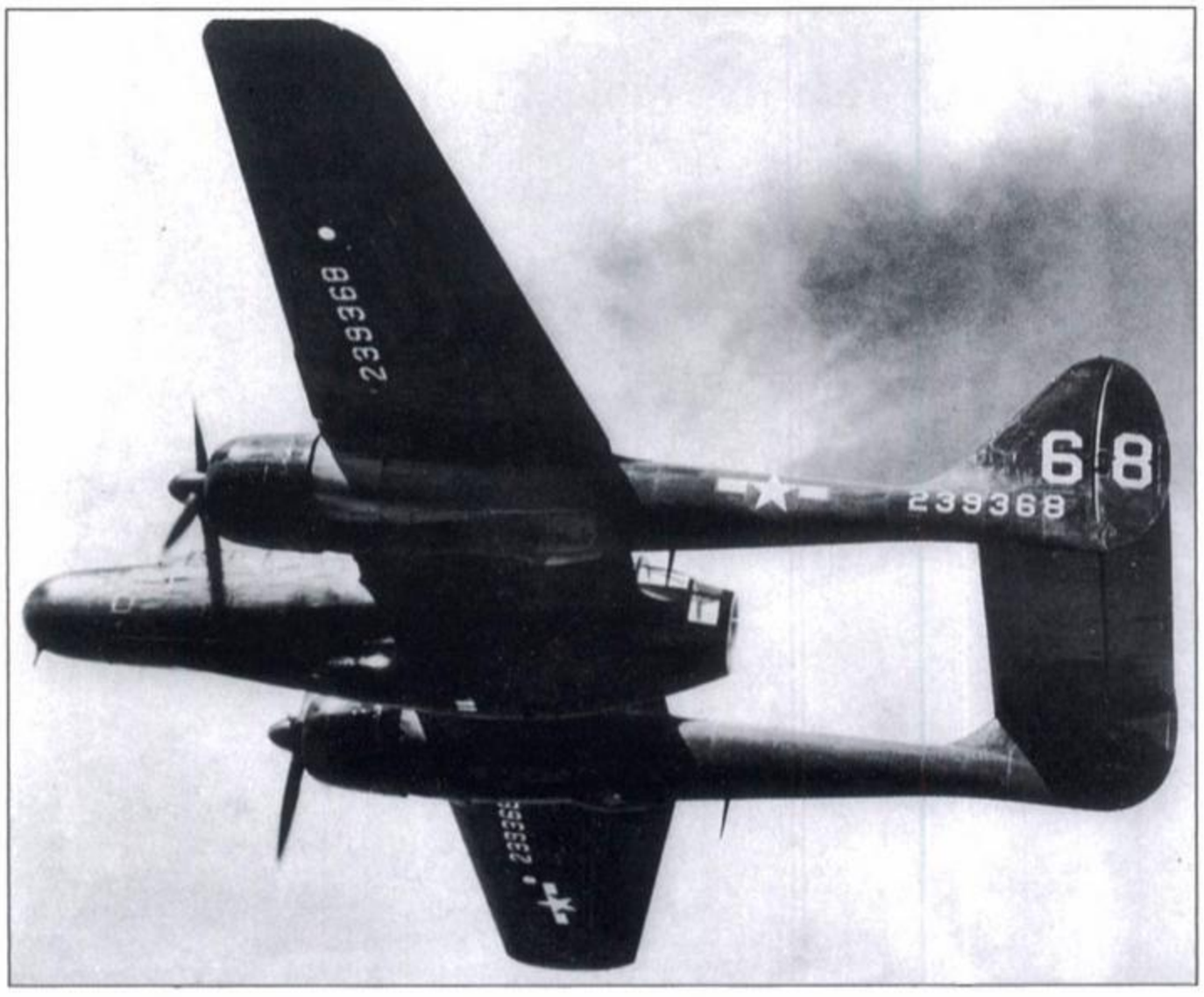
Training

The training of night-fighter crews evolved as the war moved on and the P-61 began to come on stream. Initial cadres of the NF squadrons began with Cessna T-50 Bobcats and Douglas DB-7/P-70s, later supplemented by YP-61s, in Florida. The whole training organisation (designated the 481st Night Fighter Operational Training Group) moved to California in January 1944, but was disbanded in March to be replaced by squadrons within the 450th AAF Base Unit. The specialised night-fighting training took crews up to 16 weeks to complete and included night-vision acclimatisation training with darkened goggles, and a diet high in carrots. These measures did not survive into the combat theatres.

On 26 February 1945, one of the pilots in the advanced training class at Hammer Field encountered an inflight emergency, resulting in a crash landing. The results are shown in this photograph, after the Widow had been hauled back onto its wheels.

As the Japanese became more familiar with their enemy's airborne intercept radar, they began adopting tactics to evade it, which was more feasible in a fast fighter such as the Nakajima Ki-44 'Tojo' or Kawasaki Ki-61 'Tony'. Once the enemy pilot realised that a night-fighter was tracking him, he would dive down and head for the closest land, bringing up a lot of ground clutter on the P-61's radar scope. The pursued fighter would break hard and become lost to his trackers.

Lieutenant Sorbo recalls one of his kills and the tactics the enemy pilot used. "On this one interception, we closed in faster than I would have liked. He was already using violent evasive tactics and the rapid closure allowed me to get a visual identification as he was in a sharp diving turn. He spotted us before I could fire and the pilot took his aircraft down to wave-top level. He straightened out and was egressing out of the area at top speed. I stayed well behind him. For about 10 minutes, he made continuous 'S' turns at minimum altitude while at full throttle. At all times, I was within 100 ft of the water, trying to keep below him. Finally, he must have thought he had lost us because he slowed his speed and began a straight climb. It was a fatal mistake on his part and an easy kill for us."



This P-61A-10 of a California-based training unit displays an early form of 'buzz number' in which the serial is repeated under both wings to aid in the identification of 'flat-hatters'. It was not a very practical solution.

Widely-spaced Widows

The 419th had two major detachments covering Middelburg Island and Morotai. The squadron was spread over a wide expanse of ocean and the Japanese were not being very aggressive after dark, so there was little action. For the Japanese, there was little sense in venturing out and they were well aware of the 419th's patrol areas. On 9 January 1945, Lieutenant Ralph LeVitt was vectored in behind a lone 'Betty'. The approach was from slightly below until a visual was made. Dropping back to the proper distance, the P-61's 20-mm hammered the bomber into an explosive ball of fire. It would be five months before the squadron got their fifth and final kill in the P-61.

Until January 1945, 13th Air Force was operating with

Below: Mixing aggressive young pilots with hot new fighters inevitably led to accidents. The damage to the leading edge of the right wing and the spinners of this P-61B was caused by buzzing too low to the ground and presumably flying through trees. This incident occurred at Hammer Field, California on 1 March 1945.

When it looked like the Marines were going to use the P-61 as its night-fighter, Northrop immediately started a training programme for the maintenance personnel. Here, Marine ground crew undergo instruction on the intricacies of the big R-2800 engines of a P-61A, June 1944.

China-Burma-India

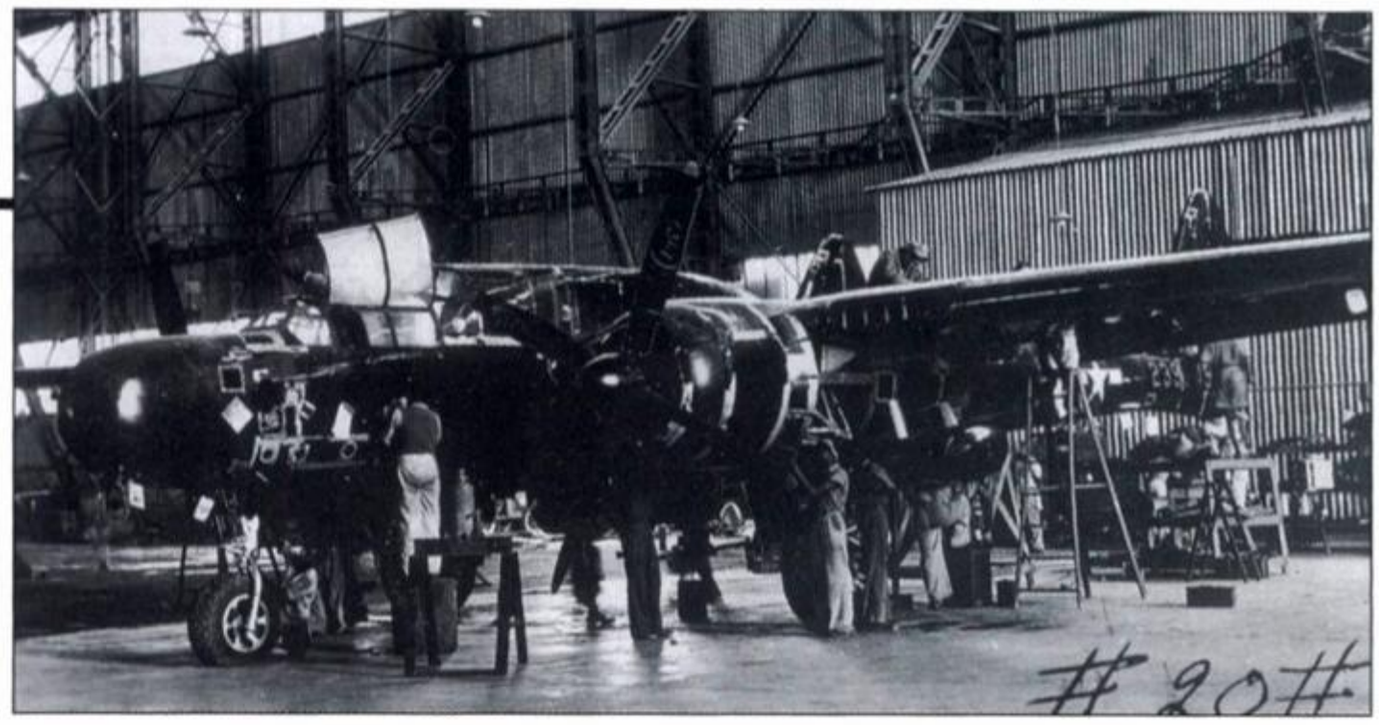
The two P-61 units assigned to the China-Burma-India theatre (CBI) arrived in China almost simultaneously in October 1944. The 427th NFS, however, had a much longer journey than its sister unit the 426th, travelling via Casablanca and Naples (where the squadron flew some patrols) before being disassembled again and shipped to India. The 426th was headquartered at Chengtu, with detachments at Kunming and other Chinese bases, as well as one in India. The 427th's operations were controlled from Myitkyina, Burma with detachments at various bases in China and India. All the luck seemed to come the way of the lower-numbered squadron, however, the 426th achieving five kills and the 427th none, although they had some success with daylight intruder missions.

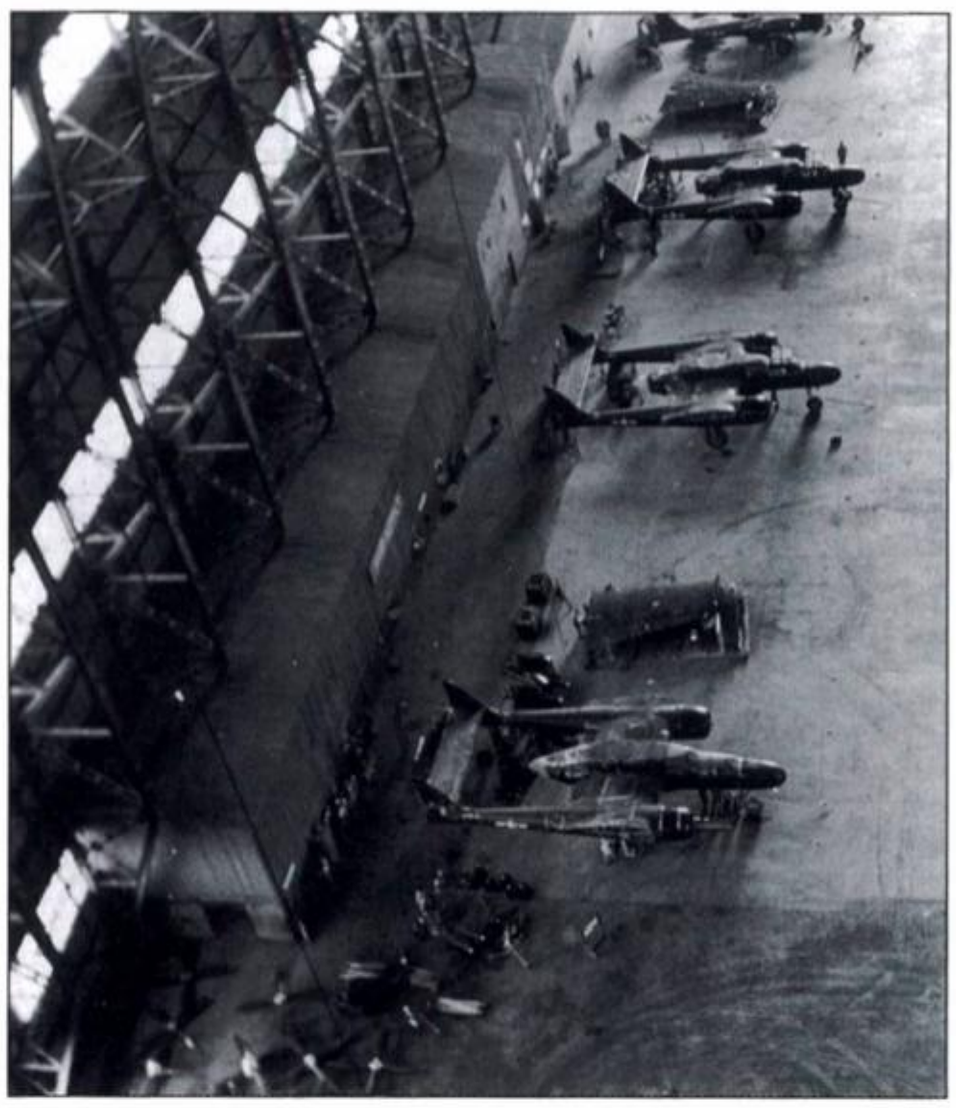
only one night-fighter squadron (the 419th). This changed on 6 January, when the newly formed 550th NFS began to receive its new P-61Bs and entered the fight. It was initially headquartered at Hollandia, New Guinea. Almost immediately, the 550th was ordered to put a detachment on Middelburg Island, from 31 December 1944 to 19 February 1945. The area of responsibility assigned to the 550th was almost void of nocturnal activity, and there was little opportunity to score kills in the Black Widows. However, they did an outstanding job in taking the war to the Japanese in the form of long night intruder missions, utilising the big external fuel tanks to the utmost. The squadron became very skilled at using external ordnance such as rockets and GP bombs. Their most effective sorties were launched from Tacloban and Zamboanga.

Between 7 July and 28 November 1944, the 421st scored 11 of its 13 kills. During the early weeks of 1945, the squadron was putting up aircraft from Tacloban and Peleliu, and suffered the same malady as other night-fighter squadrons in the Pacific: lack of Japanese traffic at night. On 24 January, Lieutenant Owen Wolf caught a prowling Mitsubishi A6M 'Zeke' and took it out. Six weeks later, on 11 March, Second Lieutenant Carl Remington was vectored onto a 'Betty' that was trying to ease into the Tacloban area, and dispatched it quickly. This was the final kill for the squadron in the war, for a respectable total of 13 kills, one probable and three damaged. It finished the war on Ie Shima, arriving on 8 August.

Fifth Air Force had the 547th NFS handling its night time coverage from the Philippine Islands in late 1944 and early 1945. On 16 January 1945, the squadron moved to Lingayen Airstrip on Luzon. If there was ever an overcrowded base, this was it, and it is possible that the concentration of targets enticed the Japanese to attempt to get through the defences, albeit on an irregular basis. While the 547th operated from Lingayen, it was able to score four of its six kills in the P-61. This proved to be unusually heavy activity for the Japanese so late in the war and in an area so far from the Japanese homeland. During this period, the squadron also had a kill in the P-38. On 13 August, the squadron made a major move to Ie Shima.

Two of the three night-fighter squadrons under the control of 7th Air Force (the 548th and 549th) logged most of their time in and around Iwo Jima, Saipan and Ie Shima. These bases were close enough to the Japanese strongholds to allow the P-61 units to make very successful night intruder forays. Whenever they took off after dark, the aircraft carried the maximum number of external tanks to increase their range. It will probably never be known just how much damage the Black Widow's 20-mm cannon did to Japanese shipping and road traffic. This new tactic removed a degree of safety that the Japanese had always enjoyed after dark. All five of the 548th's kills were made





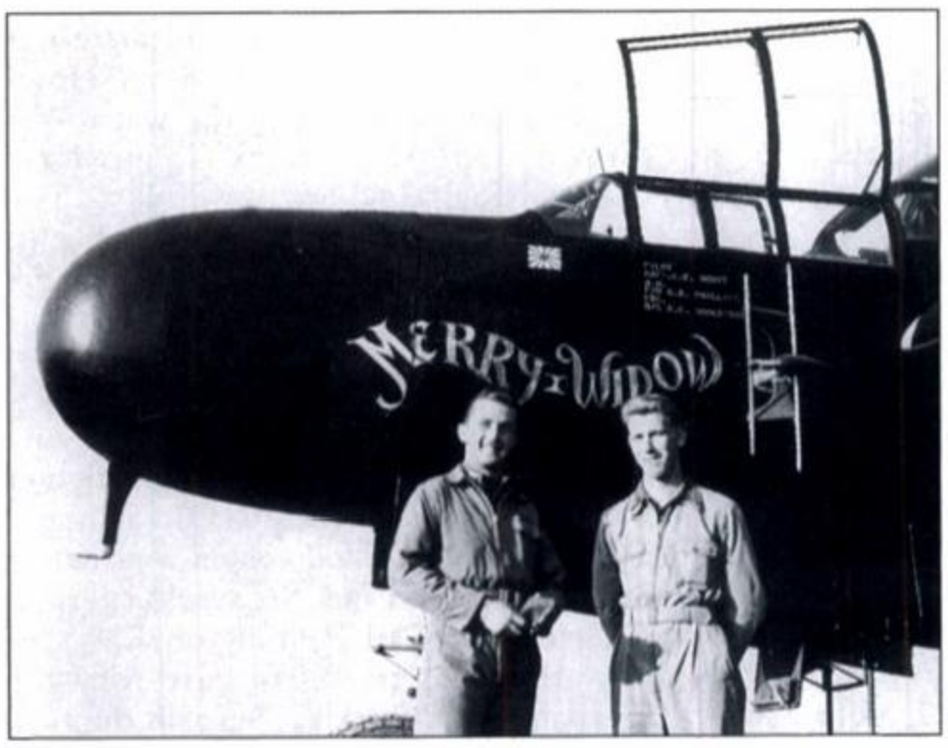
A new P-61A-10 is reassembled in a hangar at Barrackpore in India. All of the new Black Widows sent into the CBI onboard ships were processed and made combat-ready at this depot operated by the Air Service Command near Calcutta. The areas where the black finish has come off indicates where tape was placed to protect them from salt water corrosion on the voyage.

Left: This photo was also taken from high in the huge airship hangar at Barrackpore, built to house the ill-fated R-101. This first group of replacement aircraft would probably have been split between the 426th and 427th NFSs to bring them up to full combat complement.

Pilots, radar operators and maintenance officers of the 426th NFS take advantage of their new officers club ('Sloppy Joe's – open all night') at Madhaiganj, India just prior to their move to China in early October 1944. Note the squadron emblem painted on the wall above the bar.

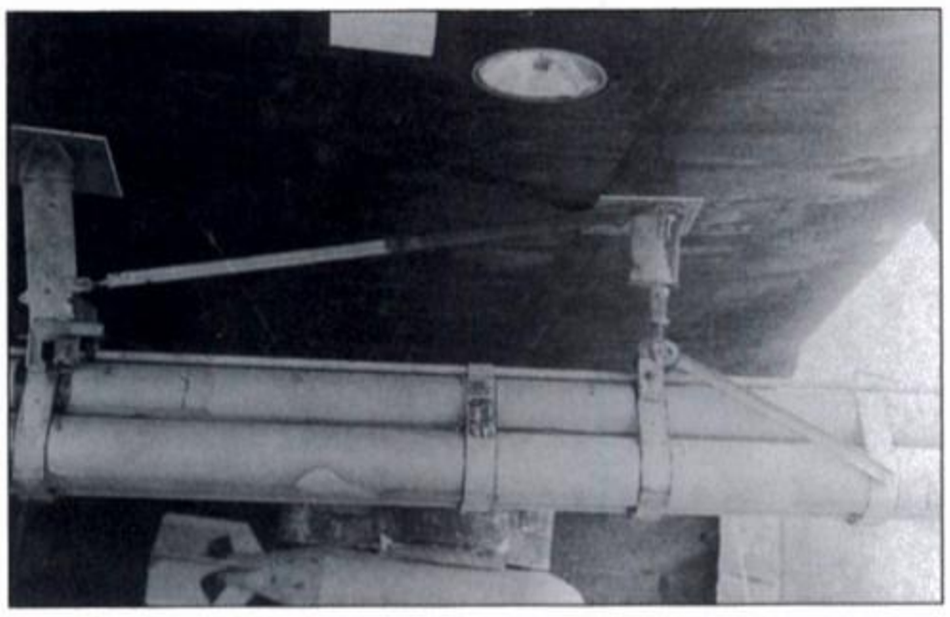
Naomi Kay, *a 426th NFS P-61A-10, rests at an isolated base in China awaiting its crew for the upcoming night's mission. It was part of a two-ship detachment sent in to stop Japanese intruders from attacking B-29 bases. Most of the 426th's kills were made by ranging out far enough to put them in a position between the Japanese airfields and the intended targets.*

The 426th NFS used 500-lb GP bombs to great advantage against Japanese troops and equipment. F/O Fred Johnson (left) and his pilot Lt Jerry Hallas pose by their P-61A **Midnight Mistress** *after it had been loaded for another bombing mission. This mission was flown from Chengtu airstrip, China in late 1944.*



This crew scored the first kill for the 426th NFS; it was also the first kill for the Black Widow in the CBI. On the left is pilot Captain Robert Scott and on the right is his radar operator, F/O Charles W. Phillips. They shot down a Ki-48 'Lily' bomber on the night of 29 October 1944, flying their assigned **Merry Widow**, *P-61A-10 42-5616.*

The aircrew of **Blood 'N Guts** *poses by its 426th Black Widow: pilot Lt Les Goodrich (left), R/O Lt Joe Neiner (middle), and an unidentified crew chief (right). The truck symbols denote interdiction missions.*



Above: With Japanese air activity rather sparse, the P-61 squadrons operating in China used their long-range external fuel tanks to fly interdiction and night intruder missions against a vast variety of targets on the ground. This picture, taken from one of a pair of P-61s returning from such a mission, shows a P-61A-10 with a D/F loop above the turret position.

Above right: The triple 4.5-in rocket ('bazooka') tubes often hung under the wings of the 427th's Black Widows were very effective against sampan traffic on the rivers, especially when combined with bombs such as the 100-lb example fitted here.

during the summer months of 1945, as was the 549th's single kill.

Lady In The Dark

On the final night of World War II – 14/15 August 1945 – the night-fighters were carrying out business as usual. The tiny island of Ie Shima was inhabited by two squadrons of P-61s, the 421st and 548th. The former had arrived on 8 August and the latter had been there since 12 June. On this night, Lieutenant Robert W. Clyde and his R/O Lieutenant Bruce K. LeFord were assigned to fly the soon-to-be-famous *Lady In The Dark*. They were scrambled early in the evening when GCI picked up a bogey on the screen, and soon LeFord started tracking the intruder on his airborne radar. A positive identification followed: it was a Nakajima Ki-43 'Oscar'. Aware that he had been discovered by the P-61, the Japanese pilot took numerous evasive actions and Lieutenant Clyde could not get into a good firing position.

The pursuit ended up just a few feet above the surface. In its high-speed jinking, the 'Oscar' hit the water and exploded, without a shot being fired. According to Air Force records, this was the final kill of the war – but *Lady In The Dark* was not finished yet! The following night of 15/16 August (when hostilities had officially ended), the 548th aircraft were on patrol; there was no guarantee that

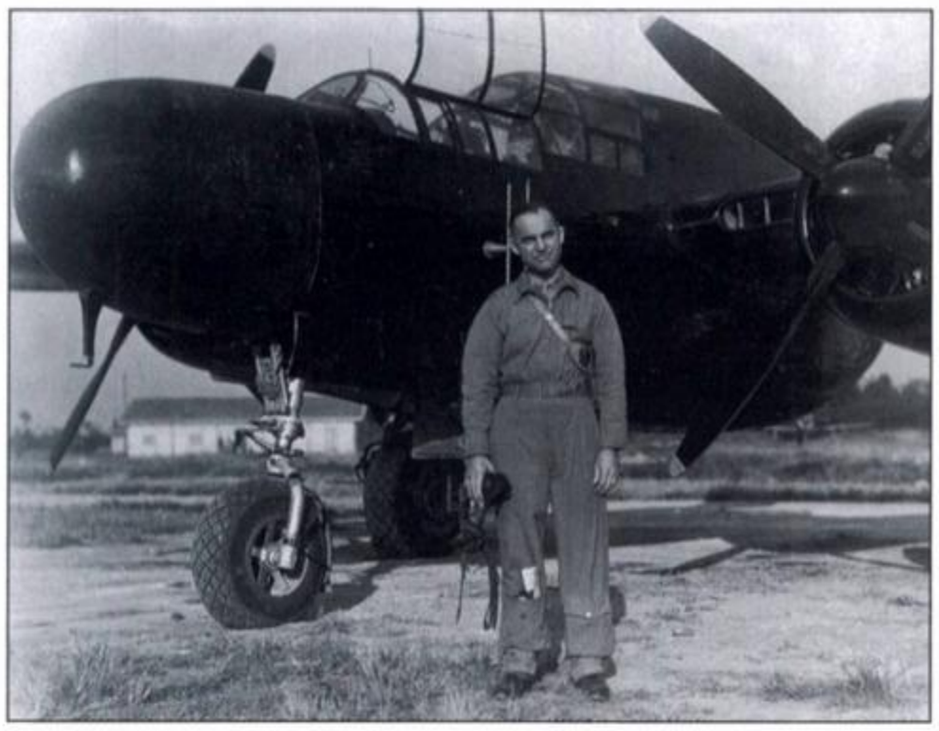
The two night-fighter squadrons assigned to the CBI had many detachments scattered around distant bases. This 426th Black Widow undergoes maintenance at Hsian, China, where it was based alongside P-47s of the 81st Fighter Group.

every Japanese unit within striking distance of Iwo Jima and Ie Shima had received word of the war's end. *Lady In The Dark* was once again slated to fly patrol, this time with its regular crew of pilot Captain Lee Kendall, R/O Lieutenant Sheerer and gunner S/Sergeant Skiles. Their callsign was BOBOLINK-55. They were airborne at 19.10 and headed for their patrol area. In a very short time, GCI picked up a single contact. *Lady* was vectored in and, at a closure speed of 300 mph (482 km/h), moved close enough to identify the intruder as a Nakajima Ki-44 'Tojo'. The Japanese fighter began a long series of violent evasive manoeuvres and used 'window' a number of times. The chase stretched over a large area and, at a very low altitude over an island, the bogey was lost in the ground clutter. It was picked up four or five times and disappeared each time. Finally, the blip did not reappear. The 'Tojo' had last been seen on the scope at an extremely low altitude, over land. Kendall circled the area for half an hour. Spotting nothing, he returned to base. The next morning, the wreckage of a 'Tojo' was confirmed by ground troops on the island. *Lady* had lashed out and made another kill and, again, no shots had been fired.

P-61 in the CBI theatre

The vast land mass of China covers over 3.5 million sq miles (9 million km²). The responsibility for protecting friendly air bases near China during the hours of darkness fell on just two American night-fighter squadrons, the

I'll Get By, ***a P-61A flown by Captain John Wilfong, displays its kill symbol (above). On the night of 21 November 1944, this aircraft shot down a Japanese Ki-48 'Lily' bomber for the second victory for the 426th NFS. Later, on 26 July 1945, Wilfong and his R/O Lt Glenn Ashley were shot down by enemy ground fire and listed as MIA; in a harrowing 19-day trek, Wilfong (left, in photo at left) and Ashley walked 150 miles (241 km) out of enemy territory. They are seen here after their safe return.***



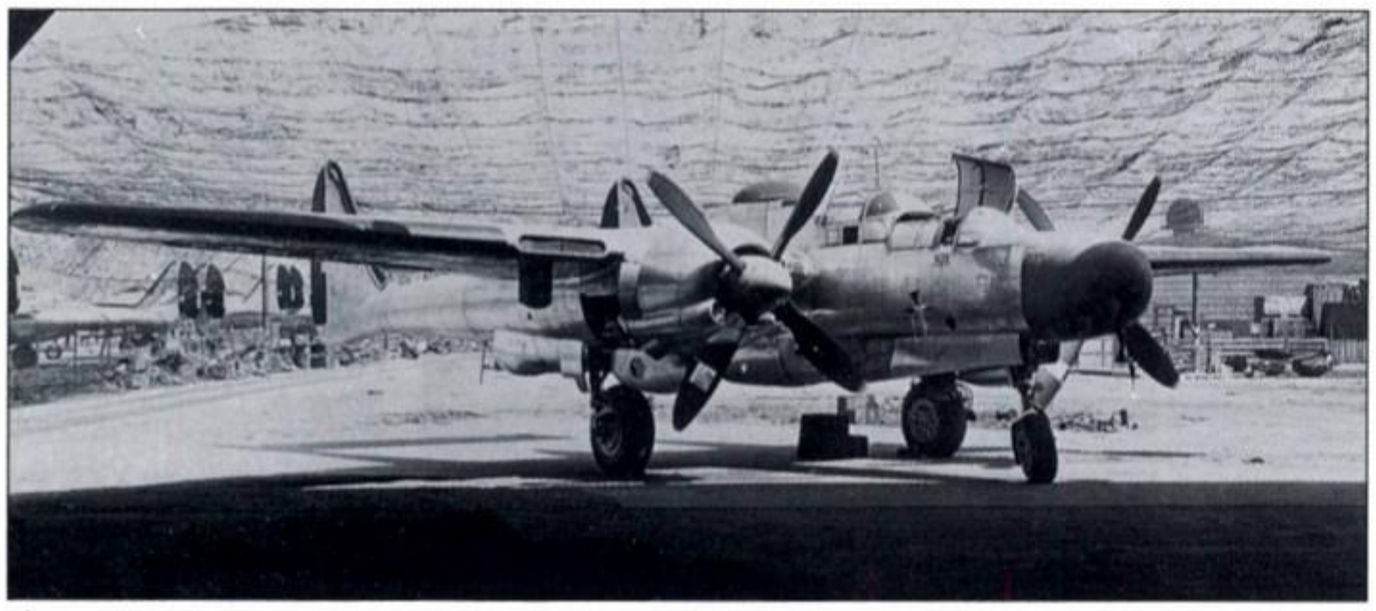
Colonel Winston W. Kratz, considered by many to be the godfather of the American night-fighter programme, stands in front of a 426th NFS P-61A at a forward base in China. At the time, he was commanding officer of the 481st Night Fighter Training Group and was on a visit to the forward areas for a first-hand look. He also had a high-level meeting with General Claire Chennault in which they discussed the need for General's support for the P-61's use in China.

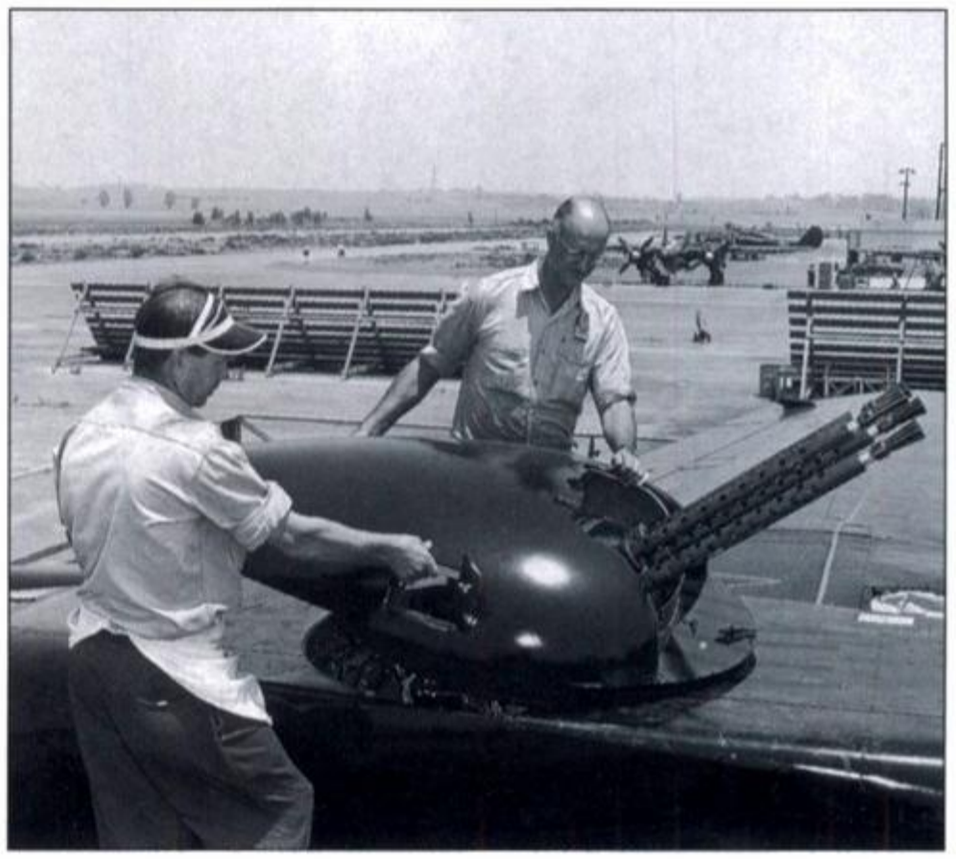
426th NFS pilot Captain John Pemberton (left) and R/O Lt Fred Cliby pose by their P-61, ship 13, named* Satan. *Although they were not credited with any kills, they certainly were not superstitious. Note the two different types of flight jackets: Cliby wears an A-2 leather jacket and Pemberton one of the newer B-10 fabric models.

A new P-61C sits under the camouflage netting at the end of the final assembly area at about the time the news came out that all of the P-61C contracts had been cancelled due to the end of the war. Note the paddle-bladed propellers.

P-61C

The P-61C was a high-performance replacement for the A and B models. The main difference was the supercharged R-2800-73 powerplants, designed to address speed and altitude deficiencies of the earlier models. To take up this extra power (2,800 hp/2088 kW) the C had paddle-bladed A.O. Smith propellers. Large bulges covered the superchargers on each nacelle. Only 41 P-61Cs, all C-1s, were built. Contracts for 476 more were cancelled.





Two Northrop technicians place the turret dome back on a P-61C after loading its 0.50-in guns. In the far distance can be seen one of the XB-35 flying wings.

426th and 427th. Both operated the Black Widow from bases in India, Burma and China. The 426th had the deepest penetration into the interior, which gave them the most exposure to Japanese intruders trying to reach the B-29 bases.

The 426th was activated on 1 January 1944 but, due to delays brought on by the move of the 481st Night-Fighter Operational Training Group from its base in Florida to Hammer Field in California, did not get into the war until late September 1944. The new P-61s were shipped to Barrackpore, India, where the Air Service Command assembled them. On 5 October, six Widows were ready, with their HF and radio compasses in place. The 426th's commanding officer, Major William Hellriegel, had been told by General Claire Chennault that the protection of B-29 bases was critical. Japanese forces in China were well aware of the destruction visited on their homeland by these big Boeing bombers, and were doing everything they could to stop them.

The 427th had been activated one month after its sister squadron, on 1 February 1944. As the men were completing their advanced training, the news that they might be sent to Poltava, Russia had their spirits running high. The United States was trying to convince the Soviets that it would be beneficial to use this base to launch scores of B-17s against Germany, and the 427th would pull the night defence assignment. The squadron embarked from Staten Island (25 July 1944) on the HMS *Puncher* with 12 new P-61s on board. They arrived at Casablanca on 8 August, towing their aircraft through the streets before thousands of curious onlookers. On 22 August, while en route to Cairo, Egypt, news arrived that the Russians had captured the Romanian oil fields.

Plans for using the Poltava base were cancelled by the host country, for the Soviets did not want American aircraft operating from their soil. The proposal for triangular bombing missions over Germany, using England, Russia and Italy as staging areas, had been called Operation Frantic. The key players had been Ambassador Averill Harriman, General Carl Spaatz and Stalin.

The first stop for the 427th was a brief combat patrol stint from Pomigliano, Italy under the control of 12th Air Force. Potentially, this put the squadron in a very advantageous position in that there were already four night-fighter squadrons in the MTO, all using Mosquitos or Beaufighters, none having received the new state-of-the-art

Correct use of the rear compartment bailout door is demonstrated at Hawthorne. The door acted as a wind deflector, aiding the radar operator's egress from a crippled aircraft.

The fighter brakes designed to prevent P-61Cs overshooting their quarry are seen in the extended position. The brakes on each wing were linked so that airflow over the wings pushed the top set back and the linkage pushed the lower set forward. After Max Stanley's narrow escape, the fighter brakes were bolted shut on all P-61Cs.

Black Widows. Due to the lack of enemy activity after dark, it was decided to move the squadron to the CBI, and on 22 September 1944 it departed for Karachi, India.

On 5 October two major events took place. First, the 426th sent four P-61s, and a B-25 for navigational purposes (flown by Major Hellriegel), over the 'Hump' and into China. Also, the 427th's commanding officer, Lieutenant Colonel James S. Michael, led all 11 of its Black Widows into Chengdu, China. While this was a great day for both night-fighter units, there was some gloom and doom at the end of the day. Orders came that, with the 426th considerably under strength, the 427th was to turn over eight of its aircraft to them. This was not well received by Michael or members of the 427th! There was another delay of a few days while the newly acquired P-61s received their HF and radio compasses, then the 426th started flying combat patrols on the night of 27 October.

The Japanese intelligence network probably had some idea a new fighter type was in the area, and would soon learn that it was not to be taken lightly. With the Japanese moving about freely under cover of darkness, there was plenty of activity for the P-61s. On 29 October, Captain Robert R. Scott, flying his assigned P-61A-10 *Merry Widow* (42-5616), shot down a Japanese Kawasaki Ki-48 'Lily', giving the Black Widow its first kill in the CBI.

'Dinah' destroyed

On the night of 21 November, the 426th claimed its second victim when Captain John Wilfong and his R/O Lieutenant Glenn Ashley shot down a Japanese bomber. They were flying their assigned P-61A-10 (42-5615) named *I'll Get By*. Wilfong recalls, "After taking off, we came under GCI control. We were vectored toward a bogey that was flying at 6,000 ft. We came in too hot and overshot him. A few minutes later, another one showed up and we were put on a heading of 270°. GCI brought me to within four miles, at which time Ashley picked it up on our scope. As we closed, the bogey commenced mild evasive action and then started a climb up to 14,000 ft. We closed in fast and were able to get a positive i.d., and it appeared to be a 'Dinah', about 600 ft ahead. Trailing at about 5° above and 5° starboard, I gave the target a quick burst with my 20-mm cannon. In an instant, the bomber exploded in front of us. It was a textbook intercept and the enemy crew never knew what hit them."

With all the changes that were made in the P-61C, it also had to undergo extreme weather condition testing. 43-8339 was a mid-production P-61C-1, probably seen here in Alaska during the winter of 1944/45. The broad-chord blades are notable.

This close-up of an accident involving P-61C 43-8324 shows the massive prop blades and the turbocharger intake . The new powerplant would have made the P-61C formidable in combat. The accident shown here was caused by a right landing gear actuating cylinder failure on 2 August 1945.

During October/November there was a severe shortage of aircraft fuel in the CBI, and the B-29s had priority. Given the situation, the 427th began to check out its pilots in the P-47: it was more fuel efficient, and if the squadron had to take on the day-fighter/night-fighter role for a short time, at least it would remain in business. In early November, a decision was made to split the 427th into two sections: one would operate from forward bases in China and the other from Myitkyina, Burma, referred to as the Burma and China Detachment. While in China, the

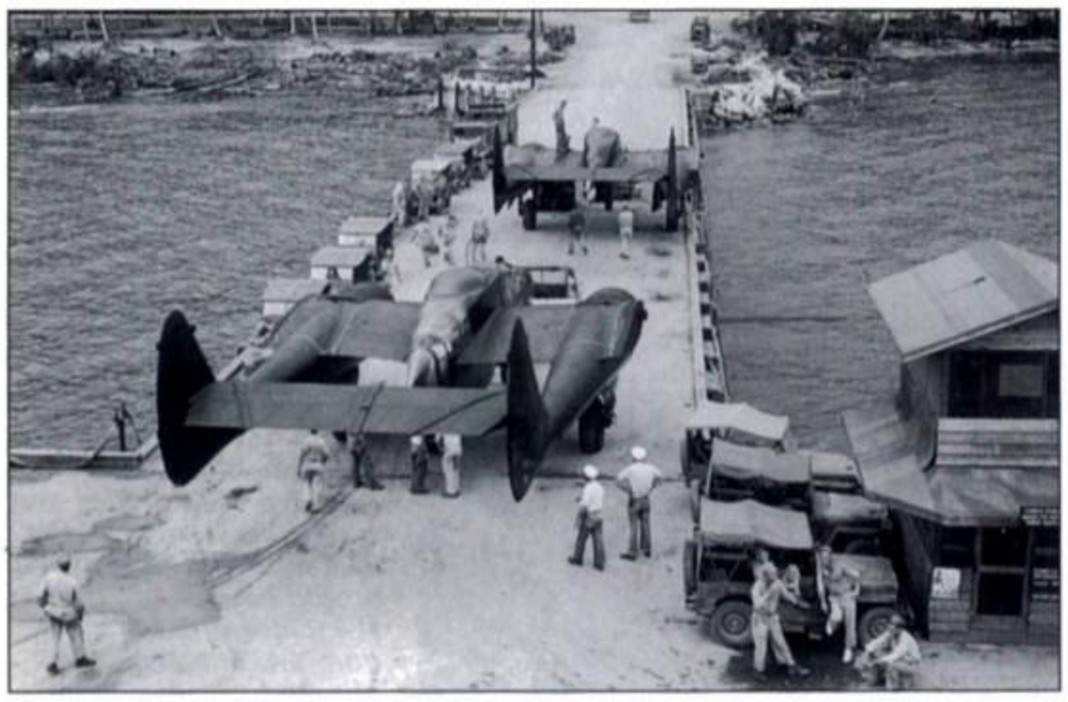
After test pilot Max Stanley activated the speed brakes of his P-61C at high speed and the required 17,000 ft (5180 m), the aircraft experienced structural failure. Stanley was thrown through the top of the cockpit by the negative g forces and was able to parachute to safety.

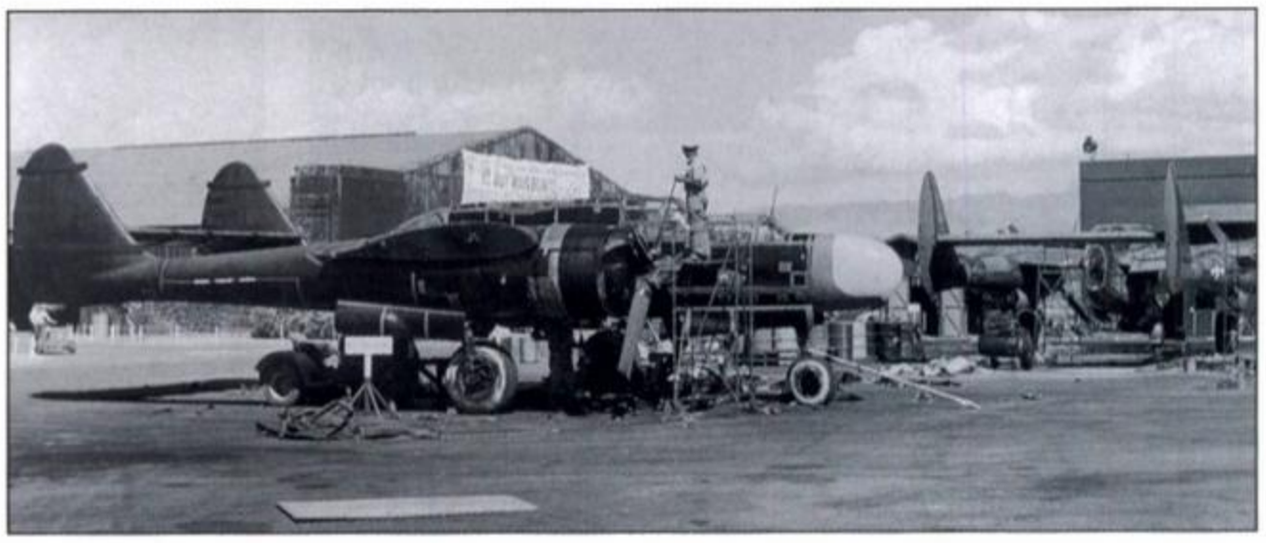
Right: Local children seem more interested in the camera than the wingless, tailless wreck of Stanley's P-61C, 29 August 1945. Falling in a flat spin, the aircraft partially buried itself near a railway line in Hawthorne.

Above: Civilian and AAC personnel unload new P-61As from ships onto Hickam Field in Hawaii in the early autumn of 1944. These would be reassembled at Hickam and shipped to the Pacific Theatre, to be flown by squadrons such as the 6th, 418th and 419th NFSs.

Pacific Theatre

Operations in the PTO were under the control of the 5th, 7th and 13th Air Forces, although as far as night-fighter operations are concerned, the distinction was somewhat blurred. The first P-61s arrived in the PTO (Guadalcanal) in May 1944, at the same time as others were being assembled in Europe. The first units to operate the P-61 in the PTO were the 419th and 6th NFSs, later joined by six others, the 418th, 421st, 547th, 548th, 549th and 550th. As the war moved on, these units 'island hopped' and had detachments on all the main bases to protect them from Japanese night raids. Areas of operation included the Solomons, New Guinea, Netherlands East Indies, the Philippines and the Japanese home islands.





Above: As more island bases became available, P-61s could be ferried by air from Hawaii. These aircraft are being reassembled and readied for flight at Hickam Field, Oahu, Hawaii on 19 January 1945.

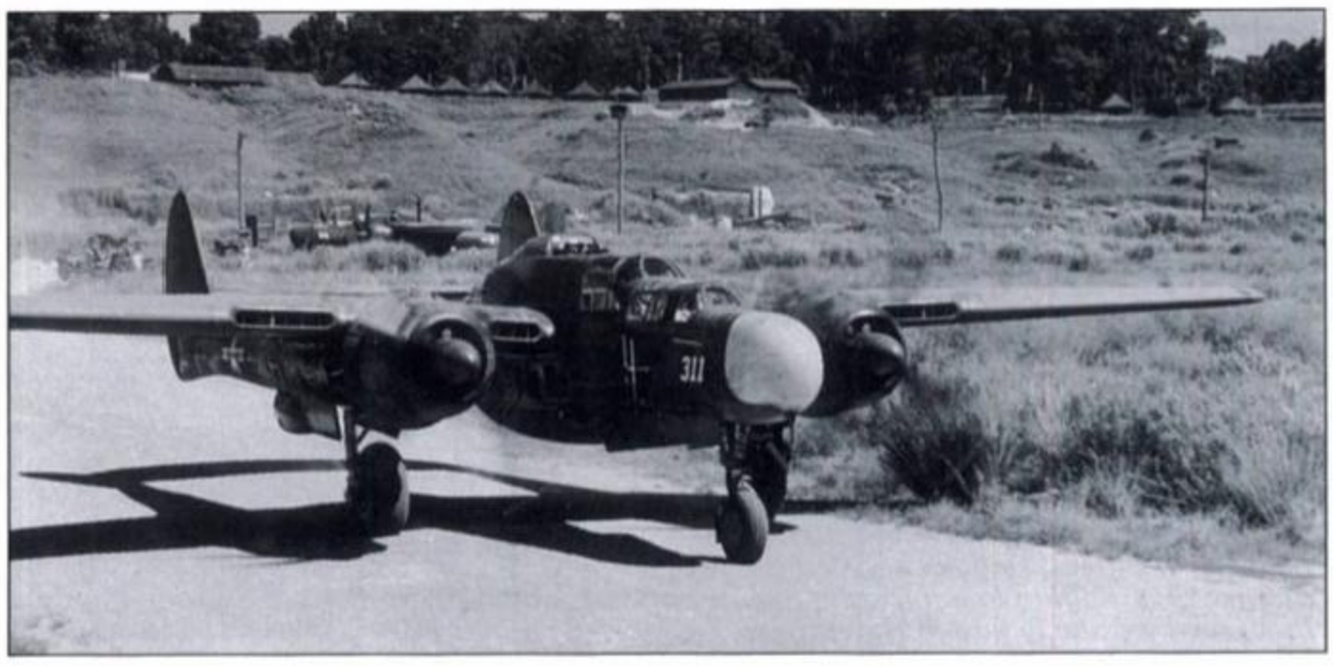
Left: New P-61s arrive at Kukum pier on Guadalcanal. Like their counterparts in Europe, their first journey after arrival in-theatre was on their own wheels to an assembly depot. These were probably destined for the 419th NFS, May 1944.

Right: When the night-fighters were stationed on Guadalcanal, they formed a very popular club called the Spider's Web. Among their regular customers were the 419th NFS, which began receiving its P-61s on 3 May 1944. Until then, they had been based on the island with P-70s.

squadron underwent a tedious training period, learning to work with GCI. It was not exciting work, as potential targets were non-existent and the six/eight-hour missions covered a huge area.

While the 426th was much closer to the action, its opportunities were drying up. In order to give his squadron a better chance of making some kills, Major Hellriegel moved two of his aircraft along with three flight crews and supporting personnel to Hsian, a forward base in northern China. It was noted that after three months of flying the Black Widow in China, the aircrews reported that when they did make interceptions the Japanese took violent evasive action. Apparently, knowledge of the devastating killing power of the P-61 had reached all of the Japanese pilots called upon to fly the night intruder missions. This made it even more difficult to obtain a kill and, in most instances, the bogey was lost on the screen.

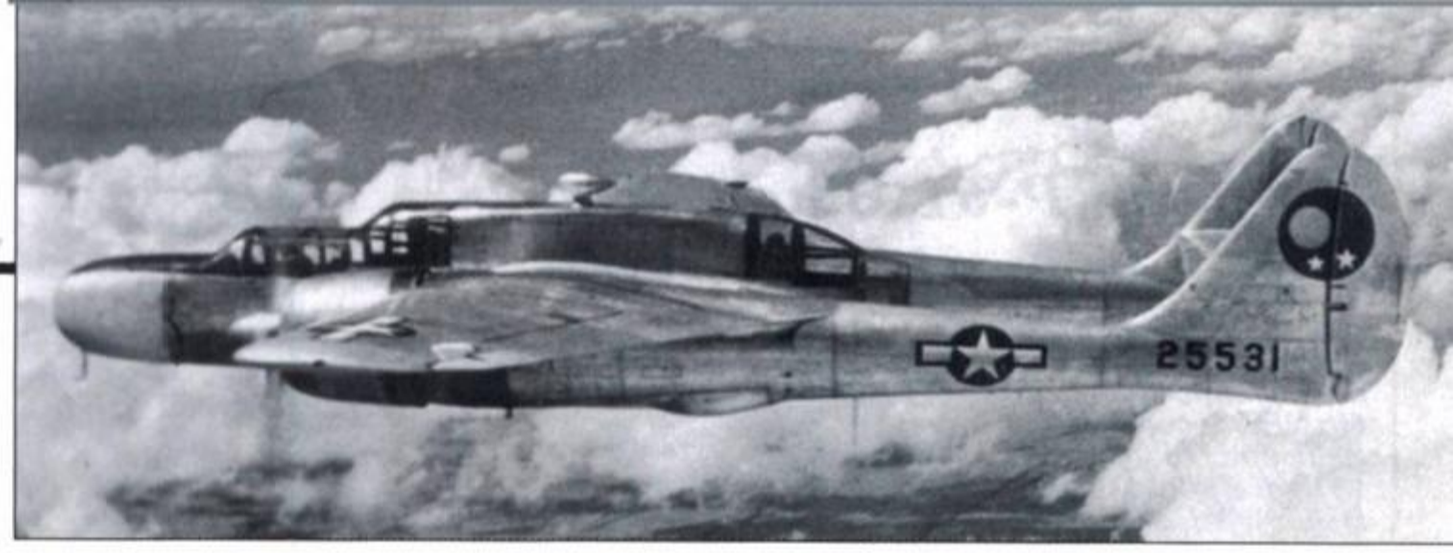
During the early weeks of 1945, the 426th was having a difficult time finding any enemy activity in the air. The final Black Widow kill of the war (in the CBI) would be made six months before the war ended. On the night of 8 February 1945, 1st Lt Harry Heise and his radar operator, F/O Robert Brock, were patrolling from Lachokow. It was about two hours before dawn and an intruder had come in



Above and right: The 419th was fairly reluctant to trade in its P-70s for the unusual new fighter until Northrop's test pilot John Myers 'sold' it to them with a memorable demonstration. He also gave each pilot instructional flights, as none of them had even seen a Black Widow until they were delivered to Guadalcanal. The 419th's P-61s were unique in having a three-digit number in the '300' range on the nose.

The silver Widow

Deep in the South Pacific Theatre, 13th Air Task Force commander General Earl W. Barnes commanded the 18th and 347th Fighter Groups (P-38s), the 42nd Bomb Group (B-25s) and the 419th Night-Fighter Squadron. He was constantly in the air, scouting for potential new bases and anything that would keep his force's momentum at a peak level. His personal aircraft for these long-distance forays was an all-silver P-61A-5 of the 419th NFS, with a long-range fuel tank inserted into the bay that was to have housed the 0.50-in turret. An impressive-looking aircraft that stood out from the others, it had a blue circle with a red centre painted on the vertical stabiliser, topped off with two white stars within the circle. General Barnes stated in a letter, "I had great enthusiasm for the P-61. I logged considerable time in the gunner's seat as we searched for the sites of new airstrips that would bring us closer to Japan." For these feats, he was awarded the Distinguished Flying Cross. The citation read: "On 19 June 1944, General Barnes made an unescorted reconnaissance flight in a P-61 aircraft to Cape Sansapor to select airdrome sites. This flight was the longest made into enemy territory up to that time."



Above: General Barnes's P-61A-5 is seen on a flight somewhere in the area of Middelburg Island in 1944. He was flying on the wing of one of his 42nd Bomb Group B-25s.

The General's P-61A was the second Dash-5 to come off the line, of 35 manufactured. The dorsal fuel tank is seen fitted in this view.

Far left: General Earl W. Barnes (in centre, with back to camera) confers with his staff at the new airstrip on Middelburg Island. Directly across from him, with sunglasses in his hand, is Colonel 'Curly' Wolfenburger, deputy commander for the task force. The all-silver P-61A can be seen in the background.

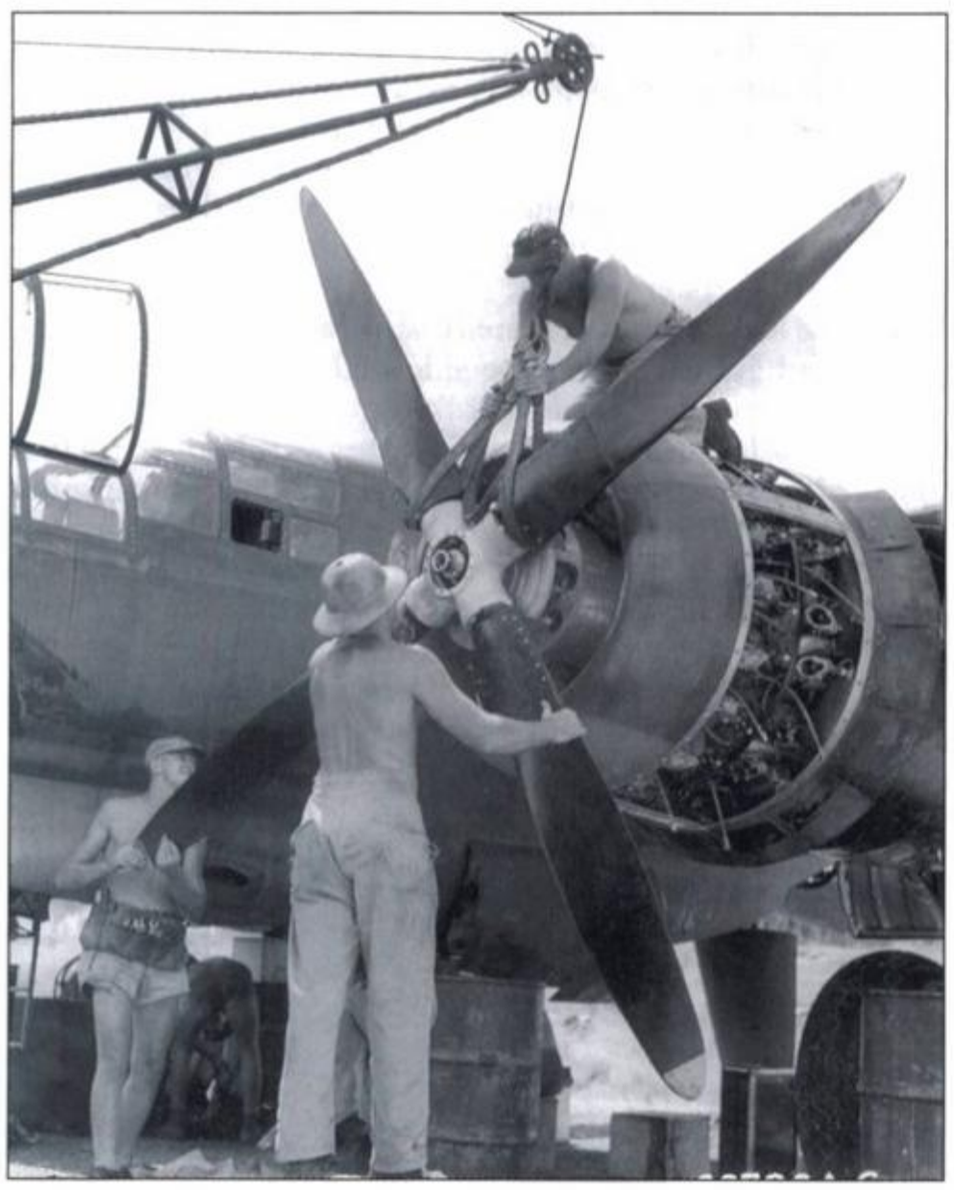
at an hour when there was usually very little aerial activity from either side. GCI vectored them in on the egressing Japanese bomber (it had already delivered its load of ordnance). Although the bogey was taking aggressive evasive action, they got to within 700 ft and made a positive identification on a 'Lily'. Heise closed to within 350 ft (107 m) and fired a short burst from his 20-mm guns. The enemy bomber exploded and fell to earth in a ball of fire.

The ability of the Japanese to know the exact locations of all 426th detachments was truly remarkable. One instance in particular shook up the aircrews. At a distant base, a crew was scrambled to intercept an incoming bogey. In the process of taxiing from the revetment to the end of the runway, the landing gear lock was accidentally released, collapsing the port gear before the pilot could correct. The propeller was thrown and the port tail boom was bent. The following day, Tokyo Rose broadcast all of the details including the fact that the detachment was left with only two operational night-fighters to cover such a vast area. The source of this information was never learned.

Although the flow of Japanese aircraft had shrunk to a trickle, neither squadron was content to stand around and wait. They began working on a new slant for the Black

Members of the Radar Maintenance Section line up for a group picture, probably soon after receiving their P-61s, for this one does not show much wear and tear. They were assigned to Detachment A of the 419th NFS, based at Morotai Island of the Moluccas Group.

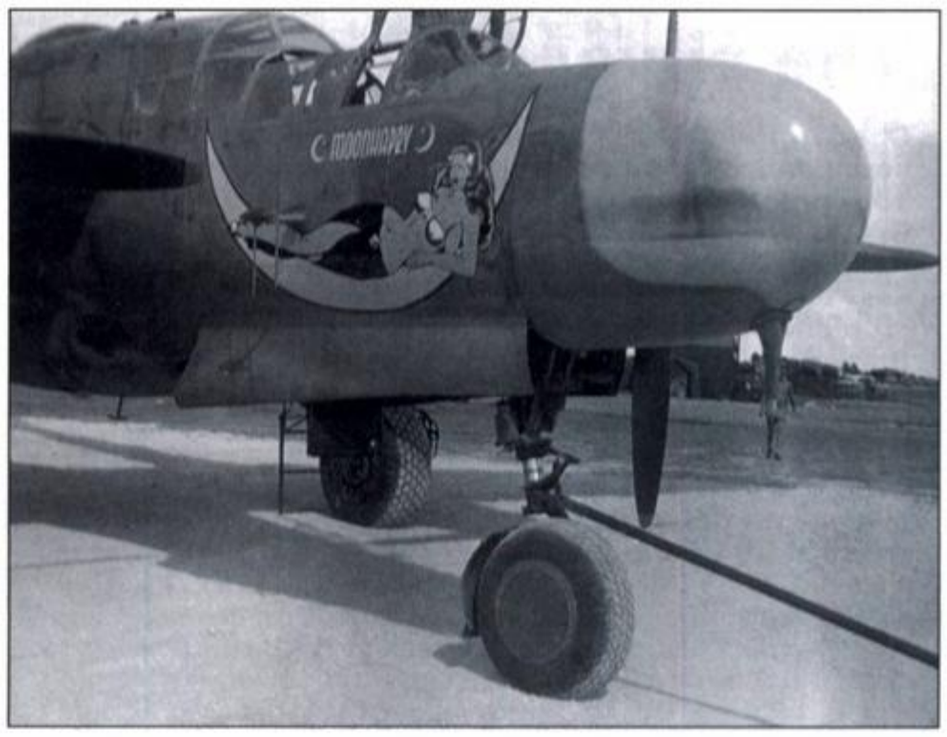
Below: The ominous silhouette of a 547th NFS Black Widow is seen here on Owi Island, New Guinea in late 1944. The aircraft – serviced, and loaded with 0.50-in and 20-mm ammunition – awaits its aircrew to show up for the night's patrol.



Above: Maintenance personnel from the 419th NFS on Guadalcanal begin the tedious process of reassembling the new Black Widows that have just arrived, by boat. Ground clearance for the 12-ft 2-in (3.71-m) Curtiss Electric propeller was 9 in (23 cm).

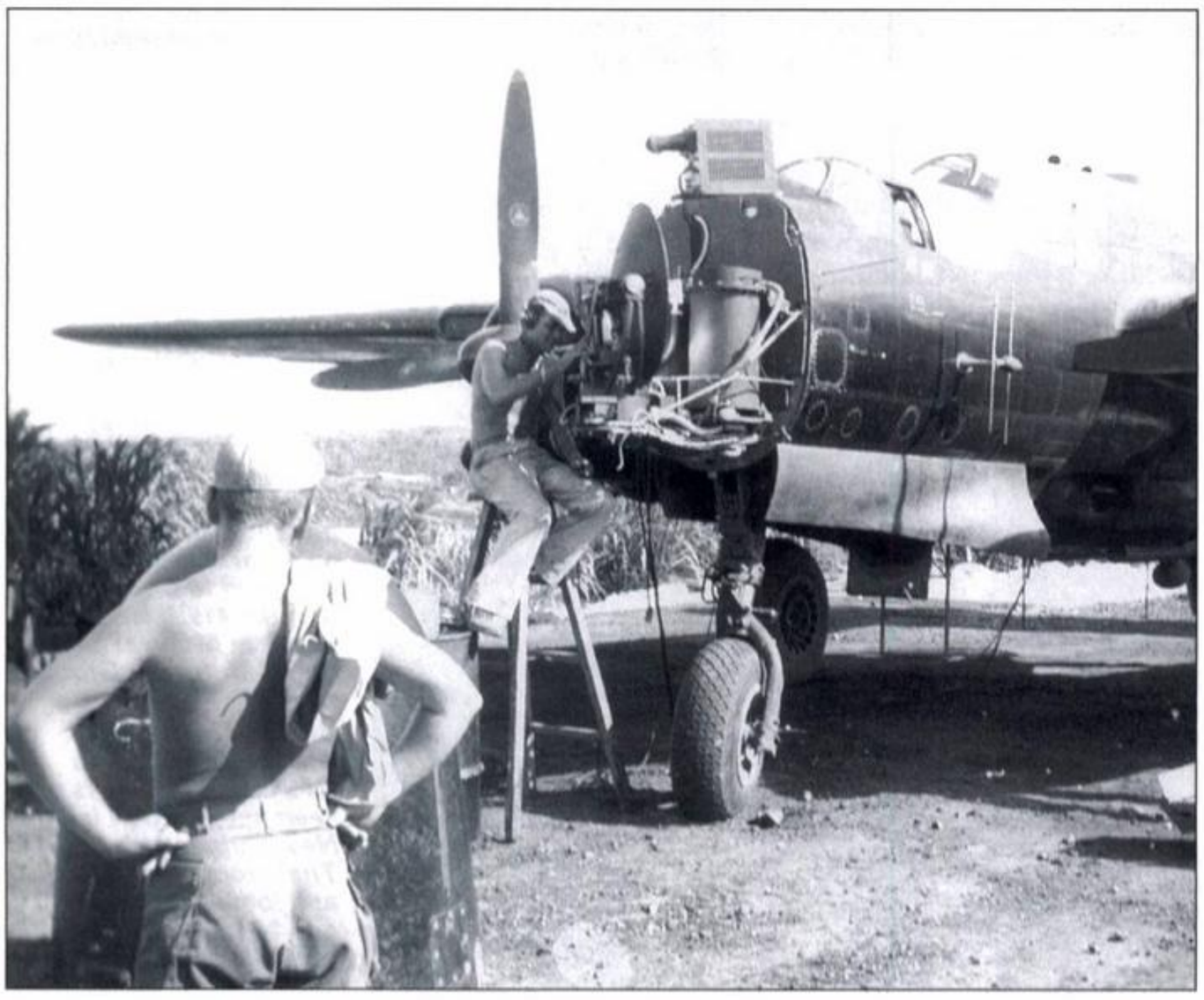
Northrop P-61 Black Widow

Moonhappy *was the most prolific killer in the 6th NFS. Second Lt Raymond Mooney, R/O (left) and pilot 1st Lt Dale 'Hap' Haberman shot down a Mitsubishi G4M 'Betty' bomber on the night of 30 June 1944, to score the squadron's first kill in the P-61. They would follow up with three more kills, barely missing the elusive acedom. Two different artworks appeared on* **Moonhappy**, *this being the more conservative.*



This was the version of* Moonhappy *to be seen on Saipan, and was painted by squadron gunner Sgt Leroy Miozzi.* Moonhappy *was a play on the crew's names.

Below: Radar mechanics work on the SCR-720 radar unit in the last days before departing Hawaii for Iwo Jima. The squadron used three bases in Hawaii: John Rodgers Field, Kipapa Gulch and Wheeler Field.



Widow, the night intruder/air-to-ground role. Both squadrons began experimenting with bombs, rockets and napalm. Lieutenant Glen Jackson, a 426th pilot flying a P-61A-10 (42-39365) named *Black Jack*, remembers a mission up the Yangtse River at Hankow. It was to be against some large gasoline storage tanks on the banks of the river. "Because of the distance we had to fly, we carried external fuel tanks. We intended to ignite the tanks with our 20-mm cannon. When we reached the area, there was a thick haze of smoke hovering over the target, caused by all the wood-burning fires from all the houses. The visibility was so bad that by the time we had the target in sight, we would have been too close to fire as the explosion would have knocked us down.

"We flew on up the river in hopes of finding a gunboat or other traffic. After a short time, we spotted a brightly lit building that had several small buildings behind it, and the entire complex was surrounded by a wall. I lined us up and we made three firing passes, with the first one blowing away the large front doors. Debris was flying all over and we were beginning to draw some automatic weapons fire. They couldn't see us, but I broke it off and returned to base. Later, we learned that we had hit the highly sought-after VIP Geisha House. The day-fighters had been searching for it for some time. I wanted to paint a window with a red light in it, on the side of *Black Jack*, but Major Hellriegel would not hear of it."

From early spring to the end of the war, both the 426th and 427th were heavily involved in day or night intruder missions, of which the 427th's records give an accurate list. They had two detachments operating from Kunming and Chungking. One daylight mission flown on 1 April, with two P-61A-10s, shows they expended 1,400 rounds of 20-mm and fired 12 rockets. They damaged five loaded sampans, destroyed one 70-ft (21-m) cargo launch, strafed

The problem of ferrying the big fighters, with their relatively short endurance of about three hours, was solved in the Pacific by filling the space left by the turret with a large fuel tank. They can be seen on these 6th NFS P-61As passing through Kwajalein Atoll on their way to Saipan in June 1944.

6th NFS nose-art

The 6th NFS had some of the most impressive artwork in the PTO.* Midnight Belle, *shown here on Ie Shima, was assigned to Captain Mark E. Martin.

The titling on the* The 'Virgin' Widow *was amended when its crew (Robert Ferguson, Charles Ward and Leroy Miozzi) scored its first victory, a 'Betty' on 26 December 1944. A less obvious addition was a ring on the widow's finger.

Above: Successful crews of the 6th NFS pose with their Air Medals (and tin helmets) in front of* Jap Batty, *which was the vehicle for two of the 6th's kills.

6th NFS pilot Lt James Crumley looks out of the cockpit in his* Husslin' Hussy. *At this time, the squadron was operating from Saipan.

docks and damaged one locomotive and several freight cars. This was a good example of what some of these missions did to Japanese ground activities.

When the war ended, the intruder missions were being flown on a regular basis and enemy air activity was all but non-existent. The small number of P-61s that had covered such a vast area had done their designated job – and much more.

Black Widow super models

As the P-61As closed out their production run and the improved B models began to move down the assembly line, Northrop was doing some serious long-range planning. The acceptance of the Black Widow by the USAAF and the night-fighter aircrews had been very positive. Now that the war on all fronts was going in a positive direction, it was time to come up with some major improvements in the product, most of which had been in the planning stages for over a year.

As the island-hopping in the Pacific continued to shrink the Japanese Empire, it was apparent that, in the event of a long-term invasion of Japan, the P-61s would need increased power and range, and to be able to deliver plenty of ordnance, all at night. The B-29s would need long-range escorts from bases in the Pacific to Japan, and *vice versa*. The P-51s would become the escort of choice in a few months, but they would be stretched to their maximum, mainly due to pilot fatigue.

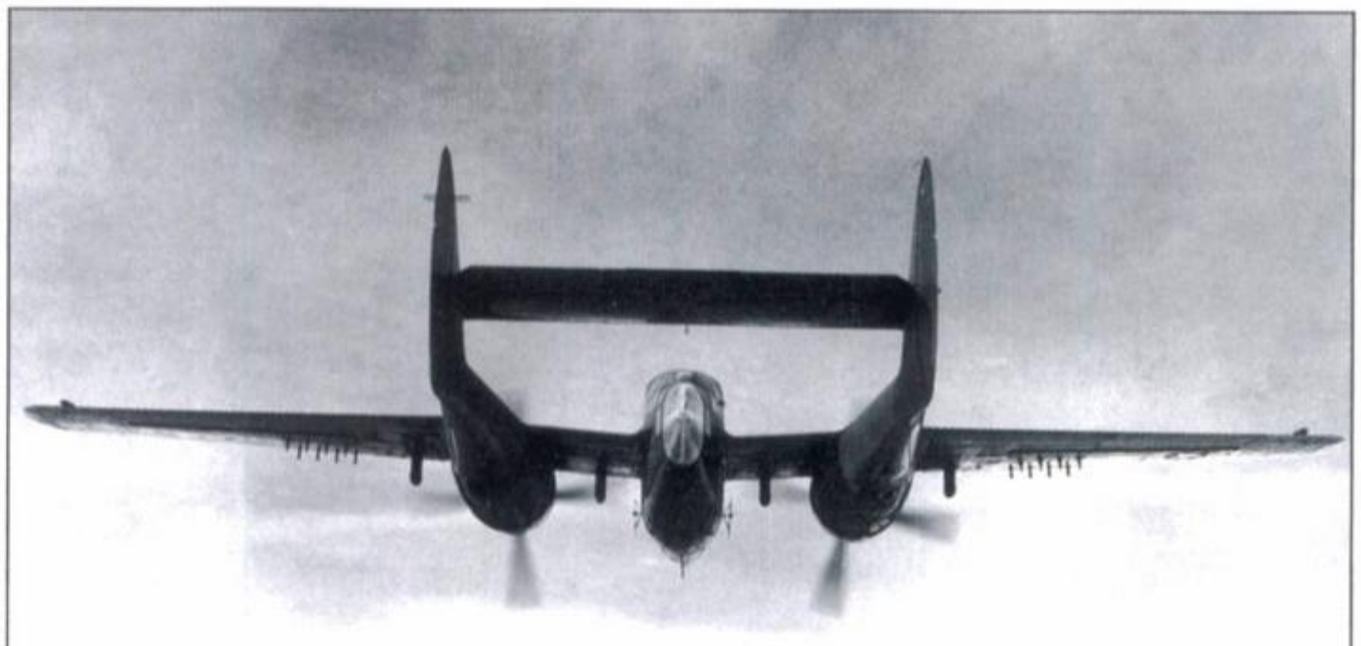
Northrop's top priority had been given to the P-61C, which would, on paper, be a dramatic improvement over the B. It also had an excellent chance to go into mass production quickly. Based on reports from the combat zones, the two characteristics that most needed improvement were altitude and speed. Both factors had been steadily improved in the German and Japanese aircraft, making it more difficult to get close enough for the kill. The C's new Pratt & Whitney R-2800-73 powerplants would address the issue of more speed, and the altitude problem would be solved by adding the General Electric CH-5 turbo-superchargers. To support these features, the massive Curtiss electric full-feathering, four bladed propellers, as used on the P-47 and B-29, were employed. Even with the weight reaching 32,200 lb (14605 kg), top speed increased to 430 mph (691 km/h) at 30,000 ft (9144 m), and service ceiling went from 33,100 ft (10088 m) in the B to 41,000 ft (12497 m). Northrop found that if the aircraft's weight exceeded 35,000 lb (10668 kg), it became sluggish, but staying below that mark led to excellent results. Had this model been ready for combat in Europe in late 1944, it would have mastered anything the Luftwaffe had, with the exception of the Me 163 or Me 262 jets. It also would have had no trouble controlling anything in the Japanese inventory.

The C could readily be distinguished from the B by the broad-chord propeller blades, the supercharger air intakes located under the engines and the two cheek carburettor air intakes on the engine cowls. Seen from the front, the Curtiss 'paddle' propellers gave the aircraft an ominous appearance.

Near-fatal speed brake test

One of the problems facing Black Widow pilots in the Pacific was the closure rate on the slower Japanese bombers. It was hard to judge the distance between the two aircraft at less than 1,000 ft (305 m), especially if the P-61 was coming in at a high rate of speed. The problem faced by the A and B models would be exacerbated with the new, high-powered C so, to counter this, speed brakes were added to the latter. They were configured on the under and upper sides of each wing, forward of the front spar. On paper, they should have solved the problem. Max Stanley, one of Northrop's seasoned test pilots, flew the greatest number of tests in the P-61C, and almost lost his life in the high-speed testing of the speed brakes. He recalls that memorable flight.

The four ordnance pylons that were a feature of most P-61Bs (and some P-61As) stand out in this view, taken from the favourite position of the night-fighter, below and behind. This view also shows the stubs for 5-in rockets, used in the intruder and interdiction roles.



Black Widow colours

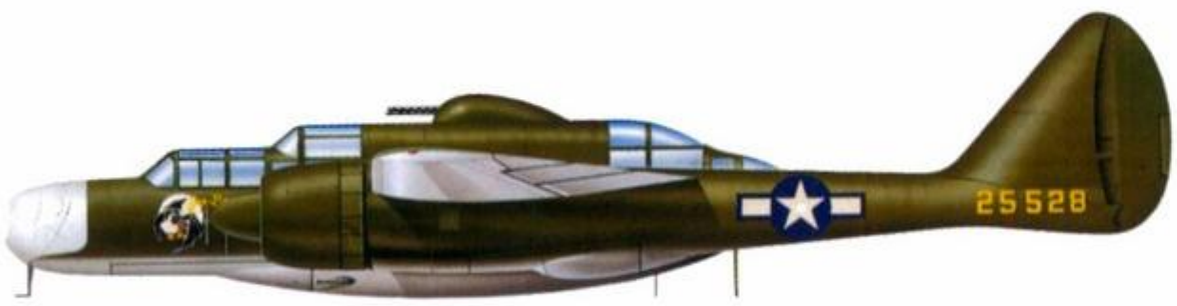
European theatre

P-61A-5 42-5536
Husslin Hussey carries the remnants of invasion stripes, having been in action in the opening weeks of Operation Overlord. Based with a detachment of the 422nd at RAF Scorton, the aircraft is finished in Olive Drab with Neutral Gray undersurfaces. Unpainted radomes, also a feature of early aircraft, were painted over in OD or black

P-61A-5 42-5564
Finished in overall Jet Black, *JUKIN' Judy* was one of the few Black Widows known to have carried a shark-mouth marking. Some sources suggest that the 'U' and 'I' in the aircraft's name were red in colour. The 35th, and final, P-61A-5 to come off the production line, 25564 was another 422nd NFS aircraft, based at Etain, France in late 1944. Invasion stripes remain on lower surfaces; the aircraft's serial number is red.

This rather grimy P-61A-10 42-5570 was a 422nd NFS aircraft and was captured in this well-known photograph, probably in France. Note the remnants of invasion stripes on the starboard boom and that the nose wheel hub has seen the attentions of a ground crewman's paint brush.

Pacific theatre



P-61B-1 42-39468
Overall Jet Black was applied from early 1944. Serial numbers were red, with 'stars and bars' often the only other markings apart from nose-art. Towards the end of the war in the Pacific, unit markings were applied. This aircraft has the horizontal, white-bordered red tail band of the 550th NFS, with propeller spinners, engine cowl flaps and wingtips in the colours of Green Flight. Underwing drop tanks were either black or unpainted.

P-61A-1 42-5528
Research conducted by MIT, the preliminary results of which were known as early as October 1943, led to the adoption of Jet Black for aircraft within the USAAF's night-fighter force. However, Materiel Command instructions to abandon Olive Drab in favour of overall black were delayed in reaching Northrop. As a result it, was not until late February 1944 that black P-61s appeared. Turret-equipped P-61A-1 *Jap Betty* equipped the 6th NFS on Saipan in November 1944. Its crew claimed two Mitsubishi G4M 'Betty' kills.

Two new P-61A-11s are seen here, parked next to the heavily camouflaged Northrop plant. Only 20 Dash-11s were manufactured, later examples introducing the ability to carry a pair of 165 US gal (625 litres) drop tanks. The aircraft in the background (42-39383) was the 17th example off the assembly line. The condition of the black finish applied to these aircraft by the time they reached units in the Pacific was a matter of concern in early 1945. Sub-standard and unapproved paints were blamed, with the result that closer checks on Northrop's conformity to specification requirements were introduced. The use of a zinc chromate primer also proved effective.

Black Widow names and nose-art

Pacific theatre

Below: Lt Bill Charlesworth, a pilot in the 549th NFS, shows off his P-61, **Hop'N Ditty**, *prior to another mission. Later, an* **Esquire** *'Petty Girl' was added in the centre of the design.*

Above: Three enlisted men from the 549th NFS line up next to CO Major Joe Payne's **Little Joe** *for a picture on Iwo Jima, summer of 1945.*

Above left: Capt. Tom Roady, the ground radar officer with the 547th NFS, is pictured with one of the squadron's Black Widows, **Hard To Get**.

Above right: The crew of **Blackout Hostess**, *radar operator Lt Dean Deines (left) and pilot Lt Robert Boucher, pose next to their aircraft on Ie Shima. Both were part of the original 548th cadre that moved out of Kipapa Gulch, Hawaii on 17 October 1944.*

Below: Lt Ernie Thomas's **Sleepy Time Gal** *was one of the best examples of 6th NFS nose-art. There were two versions of this nose-art over a period of several months.*

Below left: Sgt Walt Wernsing, the crew chief for **Sleepytime Gal**, *poses by his P-61 right after the 421st NFS settled in on Ie Shima during the final days of the war. At least four different P-61s are known to have been named* **Sleepytime Gal**.

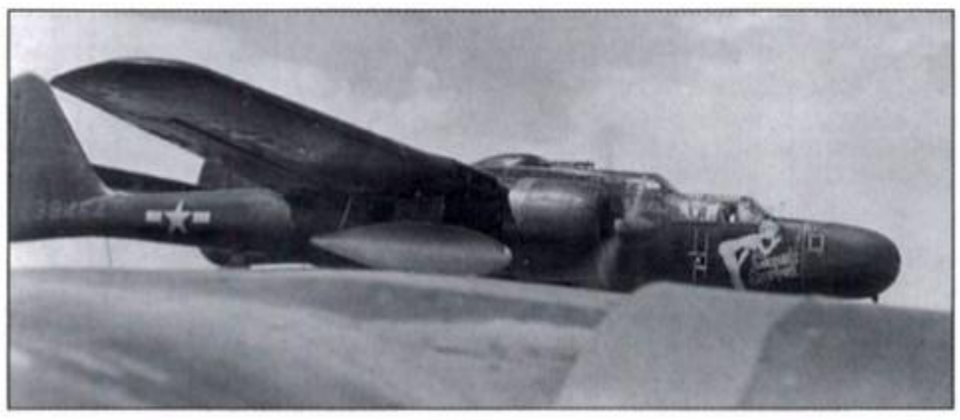
Below right: Another of the more colourful 548th NFS P-61s was **Saddle Happy**. *The aircraft's radar observer was Flight Officer Ployer P. Hill. Hill's father, Ployer P. Sr, was killed on 30 October 1935 while test flying the first B-17. Hill AFB is named after him. On the night of 5 August 1945, pilot Lt Tom Schultz and his R/O Hill shot down a 'Betty', giving them the last of the five kills with which the squadron was credited.*

Below: The top scorer in the 547th NFS was pilot Lt Arthur Bourque in his **Swing Shift Skipper**. *On the night of 19 February 1945, Bourque and his R/O, Lt Bonnie Rucks. shot down two 'Betty' bombers. Of the six kills recorded by the squadron, R/O Rucks was in on three of them.*

Left: Photographed on Saipan early in 1945, 548th NFS P-61* Our Panther *is seen here with its ground crew. Shortly after this photograph was taken, the squadron moved to Iwo Jima, recently captured by the US Marine Corps.

Right: Pilot Lt Frank Williams of the 549th NFS (right), poses with his ground crew on Iwo Jima, spring 1945.* Midnight Madonna *was flown by both Lt Williams and Lt Don Weichlein.

Nocturnal Nemesis *was flown by the 421st NFS commander Captain William Bradley. Note the parachute draped over its radome, in an effort to protect it from the heat.*



Above:* Cooper's Snooper *was P-61B 42-39454, flown by 1st Lt George C. Cooper of the 548th NFS from Iwo Jima, spring 1945, seen here on the wing of Lt Mel Bode's aircraft. Bode was the artist responsible for '*Snooper*'.

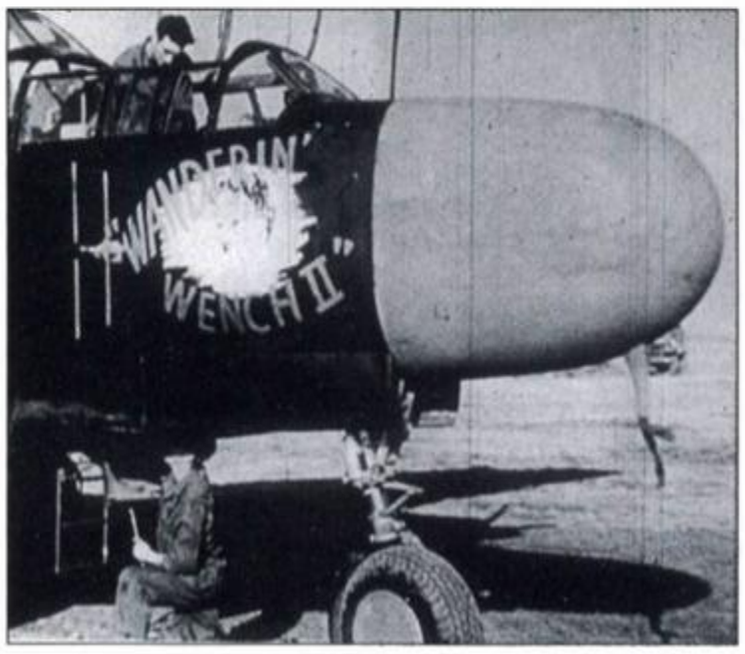
Right: Sgt Dick Dittrich 'has his way' with* Cooper's Snooper. *This pose was duplicated many times in photographs of the members of the 548th NFS.

European theatre

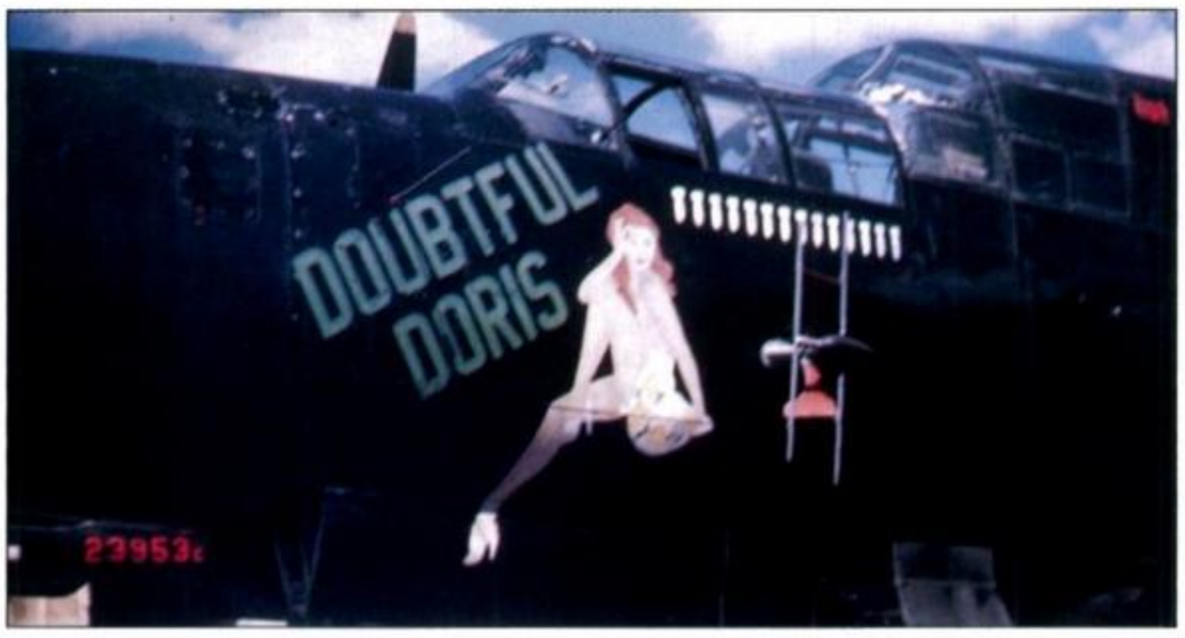
Left: Lt Earl Dickey (right), senior R/O in the 416th NFS, poses with one of his fellow officers in front of* Midnight Passion. *This photo was taken at war's end while the 416th NFS was based at Horsching, Austria.

Right: The crew of* Little Linda, *Lt James Postlewaite (middle) and Flight Officer Chet Hawley (right), pose with their crew chief at a base in England, shortly after D-Day. The overall gloss black finish was typical of aircraft being delivered to the 422nd NFS at this time.

Below left: P-61A* Wanderin' Wench II *was not often photographed. This shot of the 422nd NFS aircraft was lifted from a 16-mm film taken at a forward base somewhere in France or Belgium.



Right:* Doubtful Doris *was a P-61A of the 414th NFS. With Black Widows the 414th was based in Italy, Belgium and finally Germany between December 1944 and VE-Day. The 14 bomb symbols indicate night interdiction sorties.



Northrop P-61B-1-NO Black Widow
548th Night Fighter Squadron
301st Fighter Wing
7th Air Force
Ie Shima, Iwo Jima
June 1945

Midnite Madness I* and *II
The aircraft depicted here, 42-39404 *Midnite Madness*, was assigned to Captain James W. Bradford of the 548th NFS. On the night of 24 June 1945 at 21.40, flying from Ie Shima, Bradford, together with radar operator 1st Lieutenant Lawrence K. Lunt and gunner Master Sergeant Reno H. Sukow, destroyed a Mitsubishi G4M 'Betty'. Their quarry went down in a location noted as "20 miles SW of Point Charlie". That morning, a P-61 of the 548th's sister squadron, the 549th NFS, had destroyed another 'Betty' off Iwo Jima, for its only kill of the war.

42-39404 was the second of two P-61s with this name. Referred to as *Midnite Madness I* and *II*, their nose-art appears to have been identical, although a Roman 'II' was added under the name on 239404 at some point. The first aircraft named *Midnite Madness*, 42-5610, a P-61A-11, was one of four 548th NFS P-61s which had been working an early morning patrol off Iwo Jima on 20 April 1945. At the end of their patrol, all were caught in a dense fog that covered their landing area. *Midnite Madness* flown by Bradford made it in and blew a tyre. After coming to a stop, it was hit by the second aircraft, *The Spook*, flown by Lt Mel Bode who bounced heavily and came down on top of Bradford's Black Widow, carrying on to a crash landing. *Madness* was left standing on its wheels, but wrecked. The crew on the third P-61, *Merry Widow*, bailed out off shore and were rescued. The fourth had enough fuel to wait it out and landed safely. This 'original' *Midnite Madness* had been the first P-61 to land on Iwo Jima, on 6 March 1945.

P-61B-1 42-39404 was immediately painted to replace the first Widow, and it was in this aircraft that Bradford and crew scored their victory, one of only five credited to the squadron.The fate of *Midnite Madness II* is unclear: it eventually either ended up in the 'boneyard' at Clark AB or was lost in an accident immediately after the war. James Bradford went on to become a group commander of the Instrument School (All Weather) at Moody AFB, did a tour with the Republic of Korea AF in F-86s as a senior advisor and was involved in an exchange tour with the RAF, flying Meteor T.Mk 7s. He became wing commander at the Training Base at Laredo, Texas and finished his career with a tour at the Pentagon, retiring as a full colonel.

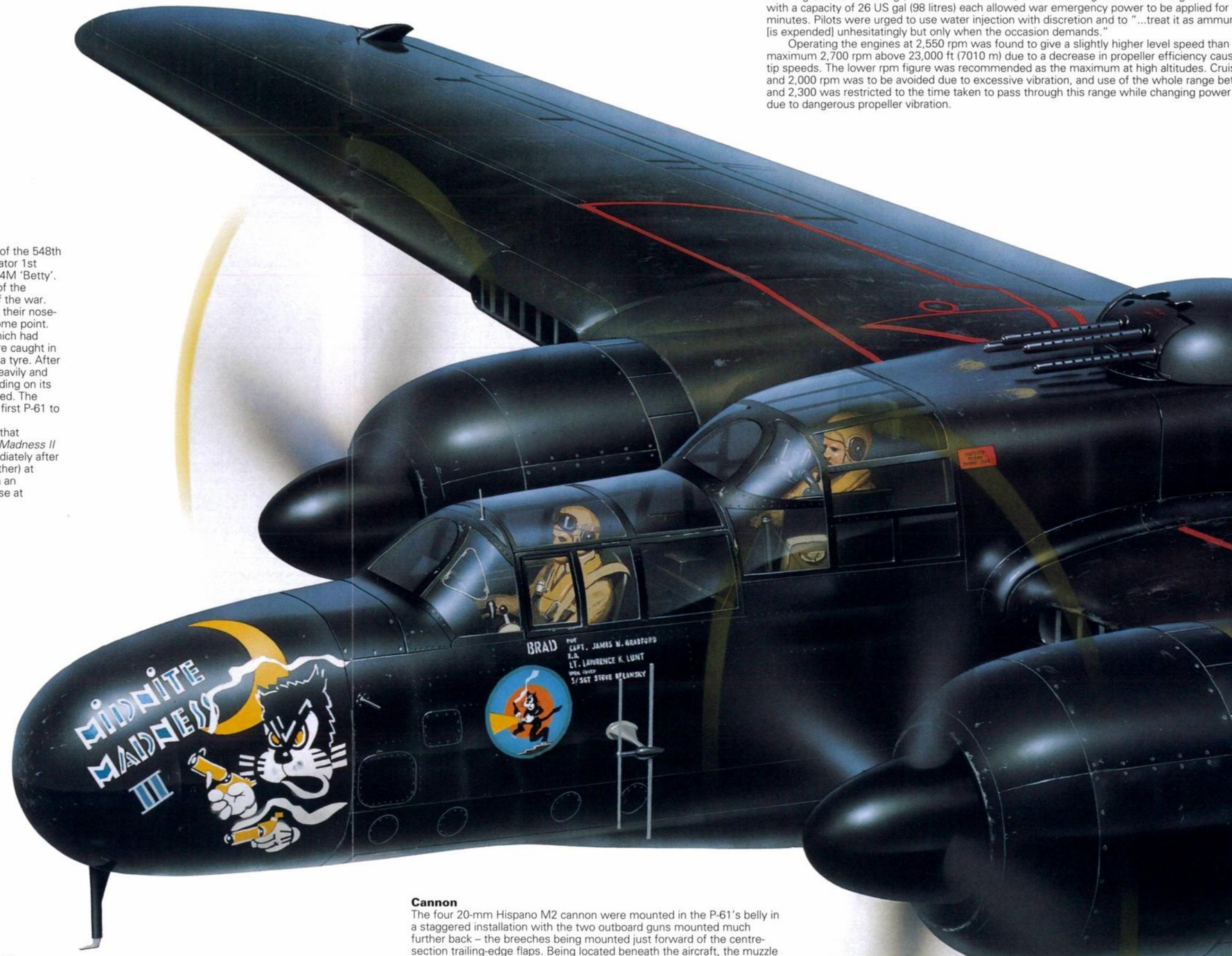
Radio equipment
In addition to the SCR-720 radar set, nearly 30 other 'black boxes' were installed in the Black Widow. In reality, this number was mainly made up of control units and junction boxes for the main radar and communication sets.The principal items found in an early P-61B included SCR-522 VHF command radio (two sets), SCR-695 IFF, SCR-718 radar altimeter, AN/APS-13 tail-warning radar and SCR-729 IFF/beacon locater. By sending out pulses and 'interrogating' ground beacons, the SCR-729 could be used as a navigation aid.

Radar
Like a number of important radars, the SCR-720 set used in the P-61 was developed by the Radiation Laboratory of MIT. Production models were built by the Western Electric Company. The advance in capability embodied by this device was brought about by the development of the cavity magnetron by the British Telecommunications Research Establishment. Using this device, the Research Construction Company (RCC, a subsidiary of the MIT lab) produced the SCR-520 (or AI-10). This was used in the YP-61s, and was developed by MIT into the SCR-720 used in production Widows. The SCR-720 operated with a 10-cm wavelength and in the frequency range of 3 GHz. Detection range was 8-10 miles (12.8-16 km) sweeping an arc 80° to 100° horizontally. In elevation, the radar could search 50° above the horizontal and between 15° and 30° below. The RC-94 parabolic reflector rotated at 350 rpm while nodding between +50° and -20° from centre. The dipole aerials mounted under the cockpit gave target azimuth, with the aft, looped rod being the antenna, and the forward rod, the director.

SCR-720 was also known by the British as the AI.Mk X (later written AI 10, not to be confused with the US AI-10/SCR-520). Much of the early production went to the RAF due to delays with the P-61, 1,000 sets being ordered in January 1943 and 1,900 a year later. This compares with total production of the P-61 (the sole US wartime user of this radar) of 742. Due to delays with the P-61, many SCR-520 sets, originally intended for the Black Widow, were converted to SCR-517 ASV sets for submarine hunting. The version fitted in the P-61B was the SCR-720C. The radar operator sat in the rear position on a padded swivel chair. When not operating the radar, he could face aft to scan the area behind the aircraft, looking for potential attackers and taking control of the turret if necessary. In some turretless P-61As, notably those of the 525th NFS, the radar equipment was moved forward to the former gunner's position. This not only improved crew co-ordination, but shifted the centre of gravity forward, lowered the nose attitude in flight and improved the top speed.

Engines
The engines used on the P-61B were Pratt & Whitney R-2800-65 Double Wasp 18-cylinder ra
at 2,000 hp (1491 kW). Late P-61s and the P-61B were fitted with water injection which prov
emergency power (also called combat emergency power). Application of water injection incr
manifold pressure to 60 in Hg at 10,000 ft (3048 m). Military power (non-combat emergency)
53 in Hg and normal rating (maximum continuous) was 49.5 in Hg at the same height. Two v
with a capacity of 26 US gal (98 litres) each allowed war emergency power to be applied for
minutes. Pilots were urged to use water injection with discretion and to "...treat it as ammu
[is expended] unhesitatingly but only when the occasion demands."

Operating the engines at 2,550 rpm was found to give a slightly higher level speed than
maximum 2,700 rpm above 23,000 ft (7010 m) due to a decrease in propeller efficiency caus
tip speeds. The lower rpm figure was recommended as the maximum at high altitudes. Crui
and 2,000 rpm was to be avoided due to excessive vibration, and use of the whole range be
and 2,300 was restricted to the time taken to pass through this range while changing power
due to dangerous propeller vibration.



Nose-art
The nose-art on *Midnite Madness* was derived from the official squadron insignia which is described in heraldic terms as "a caricatured black cat with a look of ferocity on face wearing white gloves and holding in the left forepaw a revolver, proper, emitting smoke from the barrel, while stalking across a brown fence, edged orange, in base, all in front of a large, orange, full moon". The cat on *Midnite Madness* has swapped the flashlight for another pistol and now stalks under a half moon. Unusually for a P-61, this nose art was repeated on the starboard side of the nose. The 548th was one of only a few wartime night-fighter units to regularly carry its squadron badge on the aircraft.

Cannon
The four 20-mm Hispano M2 cannon were mounted in the P-61's belly in a staggered installation with the two outboard guns mounted much further back – the breeches being mounted just forward of the centre-section trailing-edge flaps. Being located beneath the aircraft, the muzzle flash was not a threat to the crew's night vision. Containers for 200 rounds per gun were mounted fore and aft of the turret installation. The forward pair was accessible to the gunner in flight. To save on strategic materials, these boxes were initially made from a pressed fibre material that unfortunately broke down in humid conditions. Locally-made aluminium replacements had to be devised, and this material was later adopted for production.

The pilot fired the cannon with a button on the right side of the control wheel and aimed with an LY-3N gunsight (L-1 on the P-61A). Microswitches prevented the activation of the guns with the nosegear down or the ladder in place. The nosewheel had to be raised and the fuselage supported to allow boresighting of the guns.

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Operating the engines at 2,550 rpm was found to give a slightly higher level speed than the maximum 2,700 rpm above 23,000 ft (7010 m) due to a decrease in propeller efficiency caused by high tip speeds. The lower rpm figure was recommended as the maximum at high altitudes. Cruising at 1,7 and 2,000 rpm was to be avoided due to excessive vibration, and use of the whole range between 1,8 and 2,300 was restricted to the time taken to pass through this range while changing power settings, due to dangerous propeller vibration.

Turret
Due to the difficulties experienced with buffeting that occurred when the General Electric A-4 turret was rotated or elevated, the bulk of P-61As and many P-61Bs, including the P-61B-1, were delivered from the factory without the unit. The need for additional firepower, and the crew composition of units already in the field, led some Pacific squadrons to accept aircraft with fixed installations, allowing forward firing only. *Midnite Madness II* had such a fixed turret, allowing for the retention of a three-man crew who had been together since training.

The original *Midnite Madness*, a P-61A-11, had been equipped with the fully-rotating turret, which weighed 1,600 lb (726 kg) and was the same model as fitted to the B-29, which had a higher production priority – another reason why turrets were dropped from the P-61 line. The turret was fitted with four 0.50-in calibre machine-guns firing at 800 rounds per minute .Each gun had 560 rounds of ammunition. As designed, the turret could rotate 360° horizontally and up to 90° vertically, and the pilot, gunner and radio operator were all able to take control of the guns. The turret was rotated with a palm switch on the side of each grip on the sighting station, which was swung into place in front of the gunner. The guns were aimed with an N-6 reflector sight mounted on the gunner's station rather than with any periscopic system. Depressing the trigger mounted on the forward face of either grip fired all the guns. Cutouts were built in that prevented the turret guns shooting off the vertical tail surfaces or the propellers. There was no interrupter system to allow the guns to fire through the propeller arc. Allowing for firing during turret rotation would have been extraordinarily complicated given the technology of the time. The no-fire areas reduced the P-61's field of fire by about 70°. The guns could be fired over the tail fins and propellers by adjustments to the interrupter switches. Clearance over the propellers was set at 4 in (11 cm).

Revisions to the turret design solved the buffet problem and allowed reintroduction onto the assembly line. The P-61B-25 (seven converted from P-61B-15 and B-20s) tested the APG-1 gun-laying radar which linked the turret with the radar, automatically aiming the guns at the target. This device was not adopted on production Black Widows.

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Plastics
The P-61 made extensive use of non-metallic components. The nosecone was originally frosted Plexiglas, later painted to reduce its visibility. The black coat caused the Plexiglas to sag in the heat. Eventually, a new nosecone made of resin-impregnated fibreglass was introduced on the production line; this did not suffer as much from the heat and could be left uncovered on the ground. Canopy sections were made of Lucite, manufactured by Dupont.The tailcone was made of two hemispheres of Lucite cemented together along the vertical axis. After a number of these cones imploded at high speed, an aluminium reinforcing bar was added.

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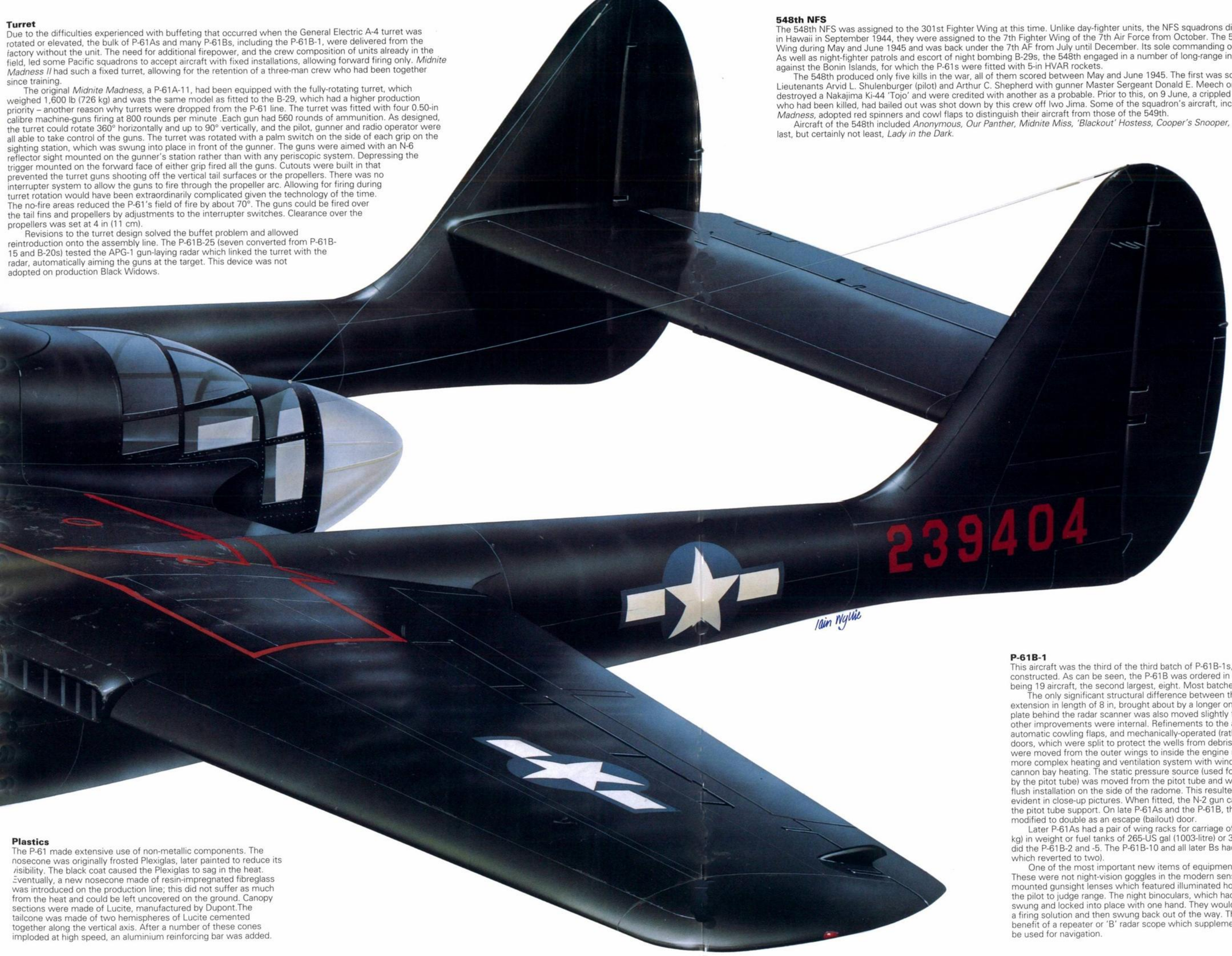
548th NFS
The 548th NFS was assigned to the 301st Fighter Wing at this time. Unlike day-fighter units, the NFS squadrons did not belong to groups. Activated in Hawaii in September 1944, they were assigned to the 7th Fighter Wing of the 7th Air Force from October. The 548th was attached to the 301st Wing during May and June 1945 and was back under the 7th AF from July until December. Its sole commanding officer was Major Robert D. Curtis. As well as night-fighter patrols and escort of night bombing B-29s, the 548th engaged in a number of long-range interdiction missions, particularly against the Bonin Islands, for which the P-61s were fitted with 5-in HVAR rockets.

The 548th produced only five kills in the war, all of them scored between May and June 1945. The first was scored by the crew of 1st Lieutenants Arvid L. Shulenburger (pilot) and Arthur C. Shepherd with gunner Master Sergeant Donald E. Meech on the night of 21 June, when they destroyed a Nakajima Ki-44 'Tojo' and were credited with another as a probable. Prior to this, on 9 June, a crippled B-29 from which all but the pilot, who had been killed, had bailed out was shot down by this crew off Iwo Jima. Some of the squadron's aircraft, including the original *Midnite Madness*, adopted red spinners and cowl flaps to distinguish their aircraft from those of the 549th.

Aircraft of the 548th included *Anonymous, Our Panther, Midnite Miss, 'Blackout' Hostess, Cooper's Snooper, Saddle Happy, Night Take-Off* and last, but certainly not least, *Lady in the Dark*.



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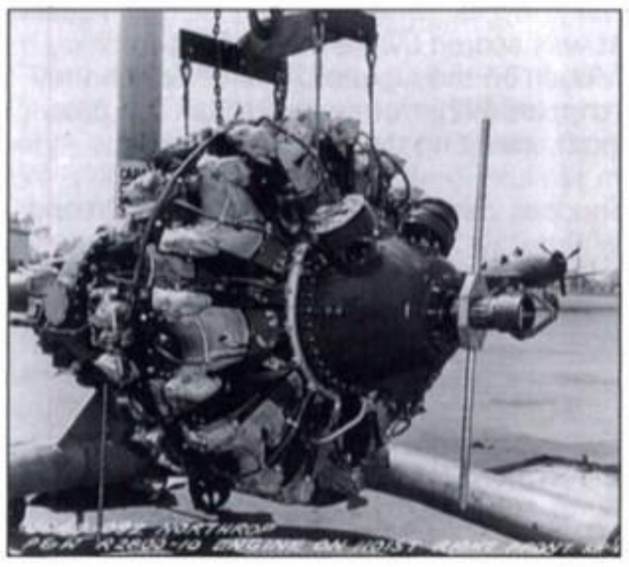
P-61B-1
This aircraft was the third of the third batch of P-61B-1s, and was the seventh P-61B constructed. As can be seen, the P-61B was ordered in very small batches, the largest being 19 aircraft, the second largest, eight. Most batches were of ones, twos and threes.

The only significant structural difference between the P-61A and P-61B was an extension in length of 8 in, brought about by a longer one-piece nosecone. The armour plate behind the radar scanner was also moved slightly farther forward on the B. Most other improvements were internal. Refinements to the aircraft systems included automatic cowling flaps, and mechanically-operated (rather than hydraulic) landing gear doors, which were split to protect the wells from debris when taxiing. The engine oil tanks were moved from the outer wings to inside the engine nacelles. P-61Bs featured a much more complex heating and ventilation system with windscreen de-icing and controllable cannon bay heating. The static pressure source (used for correcting the airspeed as read by the pitot tube) was moved from the pitot tube and was mounted under the nose, to a flush installation on the side of the radome. This resulted in a smaller-diameter tube, evident in close-up pictures. When fitted, the N-2 gun camera was mounted at the base of the pitot tube support. On late P-61As and the P-61B, the forward entrance door was modified to double as an escape (bailout) door.

Later P-61As had a pair of wing racks for carriage of two bombs up to 1,600 lb (726 kg) in weight or fuel tanks of 265-US gal (1003-litre) or 310-US gal (1173-litre) capacity, as did the P-61B-2 and -5. The P-61B-10 and all later Bs had four racks (except the -11 and -16 which reverted to two).

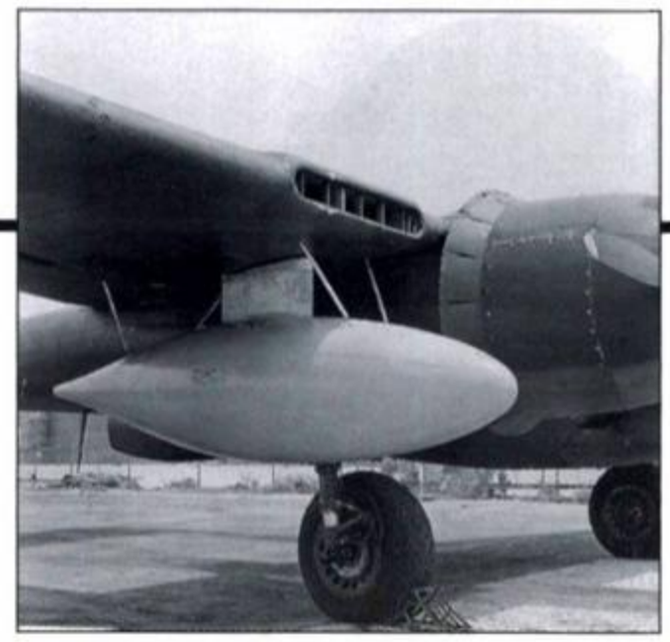
One of the most important new items of equipment was night binoculars for the pilot. These were not night-vision goggles in the modern sense, but binoculars with gimbal-mounted gunsight lenses which featured illuminated horizon marks, graduated to allow the pilot to judge range. The night binoculars, which had a 5.8x magnification, could be swung and locked into place with one hand. They would be used to help guide the pilot to a firing solution and then swung back out of the way. The P-61B's pilot also had the benefit of a repeater or 'B' radar scope which supplemented the R/O's unit and could also be used for navigation.

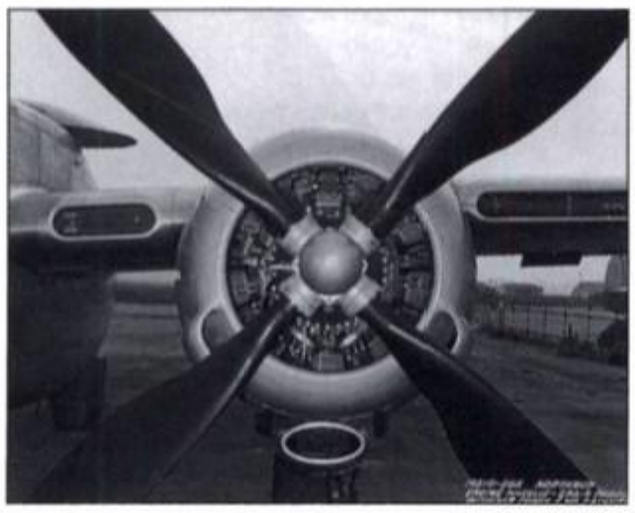
Black Widow details



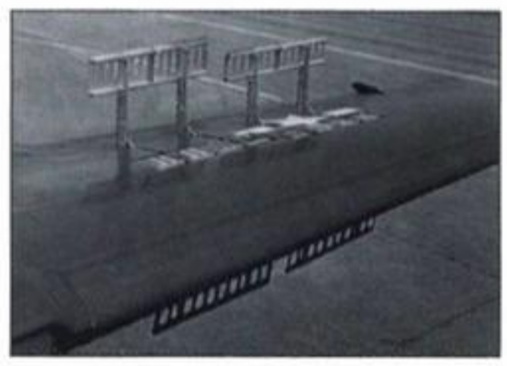
Above: The XP-61 was initially fitted with R-2800-25Ss, but engine failures caused by crankcase overpressure problems led to their replacement with R-2800-10s early in the flight test programme. Production P-61As and Bs had -10s or -65s fitted; a pair of supercharged -73s or -77s powered the P-61C, XP-61D, XP-61E and F-15A.

For its turbo-supercharged R-2800 engines, the XP-61D featured redesigned engine cowlings (below left) and a single exhaust per engine (left).





Above right: Ready for a drop test, this 310-US gal (1173-litre) tank represents one of the two standard types carried by P-61s. Two or four of these tanks, or the smaller 165-US gal (625-litre) design, were typically fitted using pylons inboard and outboard of the engines. However, as a full set of the larger tanks impaired take-off performance, they were seldom carried.



Above: So-called 'fighter brakes' were tested on a P-61C, but abandoned after a near fatal accident.

P-61B Black Widow cutaway drawing

1 Starboard navigation light
2 Starboard formation light
3 Aileron hinge fairing
4 Conventional aileron
5 Aileron tab
6 Full-span flaps (Zapp type)
7 Retractable aileron (operable as spoiler)
8 Wing skinning
9 De-icer boot
10 Intercooler controllable shutters
11 Intercooler and supercharger induction
12 Fuel filler cap
13 Starboard outer wing fuel tank
14 Nacelle fairing
15 Cooling gills
16 Pratt & Whitney R-2800-65 engine
17 Nacelle ring
18 Starboard outer auxiliary tank
19 Four-bladed Curtiss Electric propeller
20 Propeller cuffs
21 Propeller boss
22 Heater air induction
23 Front spar
24 Plexiglas canopy
25 Cannon access bulkhead cut out
26 Front gunner's compartment
27 Sighting station
28 Bullet-resistant windshield
29 Inter-cockpit/compartment armour (shaded)
30 Pilot's canopy
31 Pilot's seat
32 Control column
33 Gunsight (fixed cannon)
34 Bullet-resistant windshield
35 Fuselage structural joint (armour plate deleted for clarity)
36 Radar modulator
37 Dielectric nosecone
38 SCR 720 radar scanner
39 Gun camera (gunsight aiming point)
40 Mast
41 Pitot head
42 Radar equipment steel support tube
43 Bulkhead (centre joint)
44 Rudder pedals
45 Drag strut
46 Torque link
47 Towing eye
48 Nosewheel
49 Cantilever steel strut
50 Mud guard (often deleted)
51 Taxi lamp
52 Air-oil shock strut (shimmy damper on forward face)
53 Nosewheel door
54 Cockpit floor
55 Radar aerials
56 Gunner's compartment floor (stepped)
57 Gunner's seat-swivel mechanism
58 Cannon ports
59 Heater air induction
60 Cannon ammunition magazines
61 Ammunition feed chute
62 Four 20-mm cannon in ventral compartment
63 Magazine forward armour plate
64 Front spar fuselage cut out
65 Magazine rear armour plate
66 Rear spar fuselage cut out
67 Dorsal turrets support/drive motor
68 Front spar carry-through
69 Turret support forward armour plate
70 Flush riveted aluminium alloy skin
71 Gun mantle (four 0.50-in/12.7-mm machine-guns)
72 General Electric remote control power turret
73 Turret drive ring
74 Rear spar carry-through
75 Turret support rear armour plate
76 Radio operator/rear gunner's compartment
77 Gunner's seat-swivel mechanism
78 Plexiglas tailcone
79 Rear compartment glazing
80 Aerial attachment
81 Sighting station
82 Anti-collision beacon
83 Tailboom structure (inner stringers deleted for clarity)

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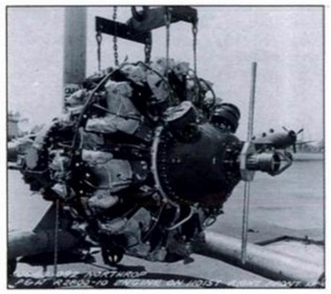
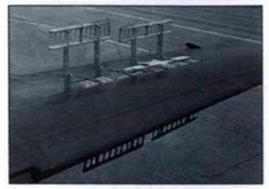
Black Widow details



Above: The XP-61 was initially fitted with R-2800-25Ss, but engine failures caused by crankcase overpressure problems led to their replacement with R-2800-10s early in the flight test programme. Production P-61As and Bs had -10s or -65s fitted; a pair of supercharged -73s or -77s powered the P-61C, XP-61D, XP-61E and F-15A.

For its turbo-supercharged R-2800 engines, the XP-61D featured redesigned engine cowlings (below left) and a single exhaust per engine (left).

Above right: Ready for a drop test, this 310-US gal (1173-litre) tank represents one of the two standard types carried by P-61s. Two or four of these tanks, or the smaller 165-US gal (625-litre) design, were typically fitted using pylons inboard and outboard of the engines. However, as a full set of the larger tanks impaired take-off performance, they were seldom carried.

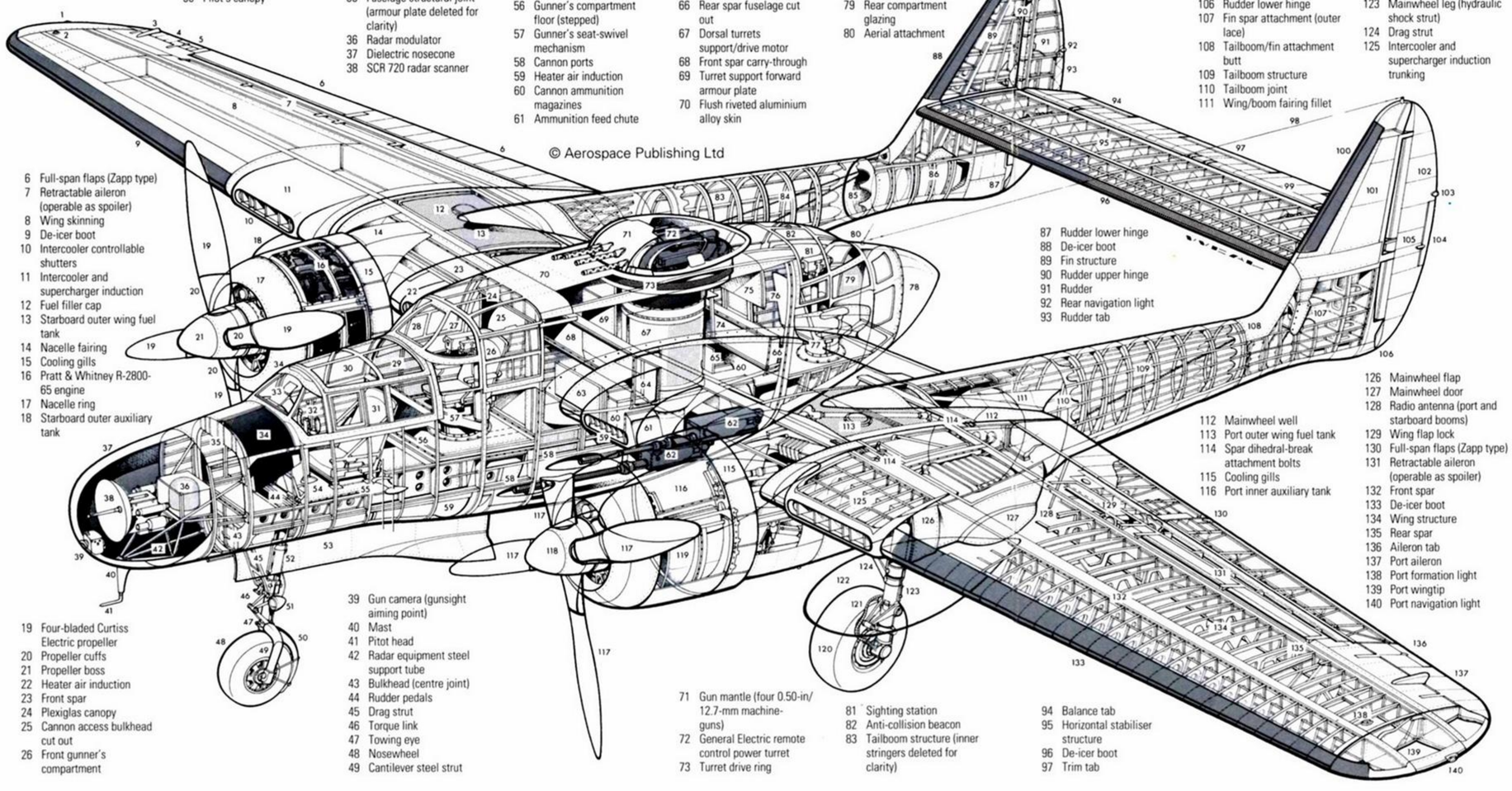


Above: So-called 'fighter brakes' were tested on a P-61C, but abandoned after a near fatal accident.

Developed by MIT's Radiation Laboratory, the SCR-720 centimetric radar set was manufactured by Western Electric and Bell Telephone, primarily for the P-61. Adopted by the British in 1943 as AI.Mk X, SCR-720 was acquired in large numbers and installed in the RAF's Mosquito NF.Mk XIX and Mk 30. Post-war it was one of the two radar types (with AN/APS-4) fitted to different night-fighter variants of the F-82 Twin Mustang. In this rare view, a P-61's nosecone has been removed for maintenance, revealing the radar's sizeable receiver dish.

P-61B Black Widow cutaway drawing

1 Starboard navigation light
2 Starboard formation light
3 Aileron hinge fairing
4 Conventional aileron
5 Aileron tab
27 Sighting station
28 Bullet-resistant windshield
29 Inter-cockpit/compartment armour (shaded)
30 Pilot's canopy
31 Pilot's seat
32 Control column
33 Gunsight (fixed cannon)
34 Bullet-resistant windshield
35 Fuselage structural joint (armour plate deleted for clarity)
36 Radar modulator
37 Dielectric nosecone
38 SCR 720 radar scanner
50 Mud guard (often deleted)
51 Taxi lamp
52 Air-oil shock strut (shimmy damper on forward face)
53 Nosewheel door
54 Cockpit floor
55 Radar aerials
56 Gunner's compartment floor (stepped)
57 Gunner's seat-swivel mechanism
58 Cannon ports
59 Heater air induction
60 Cannon ammunition magazines
61 Ammunition feed chute
62 Four 20-mm cannon in ventral compartment
63 Magazine forward armour plate
64 Front spar fuselage cut out
65 Magazine rear armour plate
66 Rear spar fuselage cut out
67 Dorsal turrets support/drive motor
68 Front spar carry-through
69 Turret support forward armour plate
70 Flush riveted aluminium alloy skin
74 Rear spar carry-through
75 Turret support rear armour plate
76 Radio operator/rear gunner's compartment
77 Gunner's seat-swivel mechanism
78 Plexiglas tailcone
79 Rear compartment glazing
80 Aerial attachment
84 Control runs
85 Tailboom/fin attachment
86 Fin spar attachment (inner face)
98 Aerials
99 Elevator
100 De-icer boot
101 Port fin
102 Rudder
103 Rear navigation light
104 Rudder tab
105 Tab hinge fairing
106 Rudder lower hinge
107 Fin spar attachment (outer lace)
108 Tailboom/fin attachment butt
109 Tailboom structure
110 Tailboom joint
111 Wing/boom fairing fillet
117 Four-bladed Curtiss Electric propeller
118 Propeller boss
119 Nacelle construction
120 Port mainwheel
121 Hydraulic and airbrake pressure lines
122 Port outer auxiliary tank
123 Mainwheel leg (hydraulic shock strut)
124 Drag strut
125 Intercooler and supercharger induction trunking



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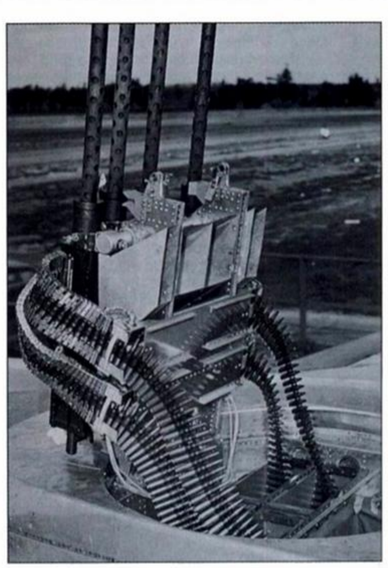
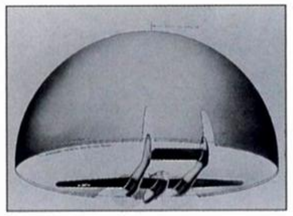
6 Full-span flaps (Zapp type)
7 Retractable aileron (operable as spoiler)
8 Wing skinning
9 De-icer boot
10 Intercooler controllable shutters
11 Intercooler and supercharger induction
12 Fuel filler cap
13 Starboard outer wing fuel tank
14 Nacelle fairing
15 Cooling gills
16 Pratt & Whitney R-2800-65 engine
17 Nacelle ring
18 Starboard outer auxiliary tank
19 Four-bladed Curtiss Electric propeller
20 Propeller cuffs
21 Propeller boss
22 Heater air induction
23 Front spar
24 Plexiglas canopy
25 Cannon access bulkhead cut out
26 Front gunner's compartment
39 Gun camera (gunsight aiming point)
40 Mast
41 Pitot head
42 Radar equipment steel support tube
43 Bulkhead (centre joint)
44 Rudder pedals
45 Drag strut
46 Torque link
47 Towing eye
48 Nosewheel
49 Cantilever steel strut
71 Gun mantle (four 0.50-in/12.7-mm machine-guns)
72 General Electric remote control power turret
73 Turret drive ring
81 Sighting station
82 Anti-collision beacon
83 Tailboom structure (inner stringers deleted for clarity)
87 Rudder lower hinge
88 De-icer boot
89 Fin structure
90 Rudder upper hinge
91 Rudder
92 Rear navigation light
93 Rudder tab
94 Balance tab
95 Horizontal stabiliser structure
96 De-icer boot
97 Trim tab
112 Mainwheel well
113 Port outer wing fuel tank
114 Spar dihedral-break attachment bolts
115 Cooling gills
116 Port inner auxiliary tank
126 Mainwheel flap
127 Mainwheel door
128 Radio antenna (port and starboard booms)
129 Wing flap lock
130 Full-span flaps (Zapp type)
131 Retractable aileron (operable as spoiler)
132 Front spar
133 De-icer boot
134 Wing structure
135 Rear spar
136 Aileron tab
137 Port aileron
138 Port formation light
139 Port wingtip
140 Port navigation light

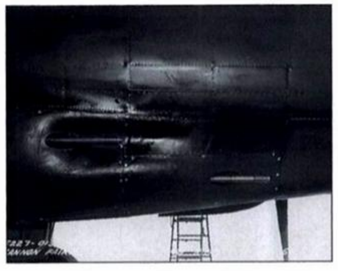
Armament

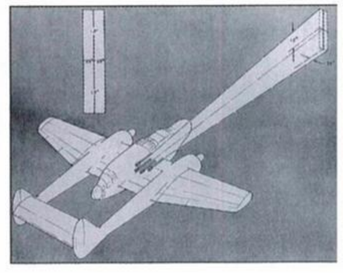
Though not always fitted, the P-61's 1,600-lb (726-kg) General Electric upper turret (right) had an almost unobstructed field of fire (below), covering almost the entire hemisphere above the aircraft. Each of its four 0.5-in machine-guns, with an 800 rpm rate of fire, was supplied with 560 rounds. Buffeting problems, prevalent when the guns were elevated, and the subsequent delays, plus priority accorded the Boeing B-29 (which used the same turret) led to their omission from late-production P-61As and early B models. Rather than do without the upper guns, some aircraft in the Pacific theatre flew with their turrets fixed in the forward position.





Below left and below: Four 20-mm cannon formed the Black Widow's primary offensive armament. Each was fed with 200 rounds and aimed by the pilot using a Type L-1 (P-61A), or a Type LY-3N (P-61B) sight.





Specifications

P-61B Black Widow

Type: two/three-seat night-fighter
Powerplant: two Pratt & Whitney R-2800-65 Double Wasp 18-cylinder radial engines with a 2,000-hp (1491-kW) military rating and a 2,250-hp (1678-kW) war emergency rating
Weights: empty 23,450 lb (10637 kg); maximum overload 36,200 lb (16420 kg)
Dimensions: wing span 66 ft ¾ in (20.11 m); wing area 662.36 sq ft (61.53 m²); length 49 ft 7 in (15.11 m); height 14 ft 8 in (4.47 m)
Performance: maximum speed (at war emergency 2,250 hp/1678 kW engine rating) 366 mph (589 km/h) at 20,000 ft (6096 m); initial climb rate (military power) 2,090 ft/min (637 m/min); range (long-range cruise power) 1,350 miles (2172 km) at 229 mph (368 km/h)
Armament: four 20-mm M2 cannon each with 200 rounds; (on some aircraft) dorsal turret with four 0.5-in (12.7-mm) Colt-Browning machine-guns each with 560 rounds; four external pylons each rated at up to 1,600 lb (726 kg) and able to carry bombs or other stores.

F-15A Reporter

Type: two-seat photographic reconnaissance aircraft
Powerplant: two Pratt & Whitney R-2800-73 Double Wasp supercharged 18-cylinder radial engines with a 2,100-hp (1566-kW) military rating and 2,800-hp (2088-kW) maximum rating with water injection
Weights: 32,190 lb (16420 kg) max
Dimensions: wing span 66 ft ¾ in (20.11 m); wing area 662.36 sq ft (61.53 m²); length 50 ft 4 in (15.34 m); height 14 ft 8 in (4.47 m)
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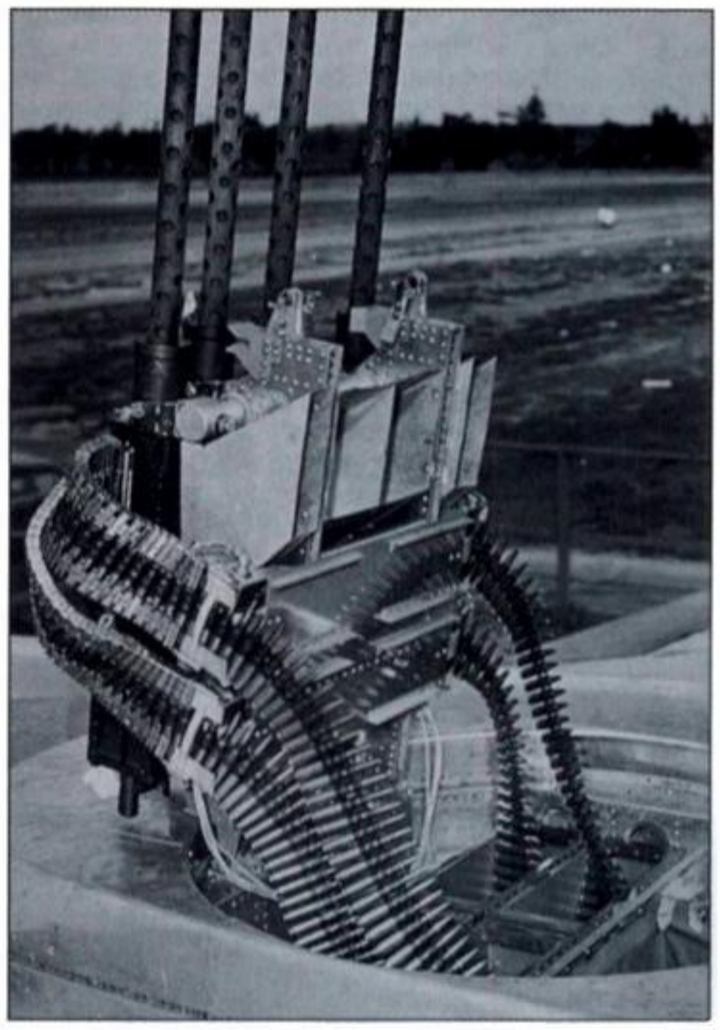

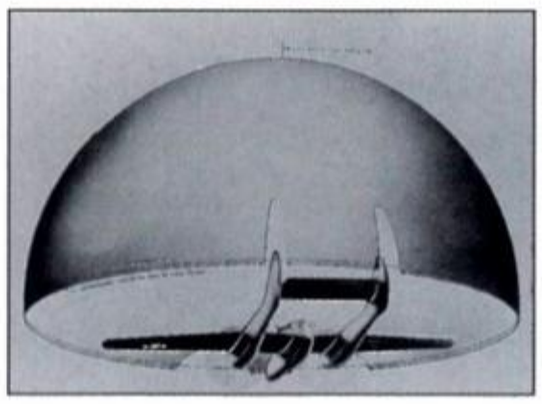

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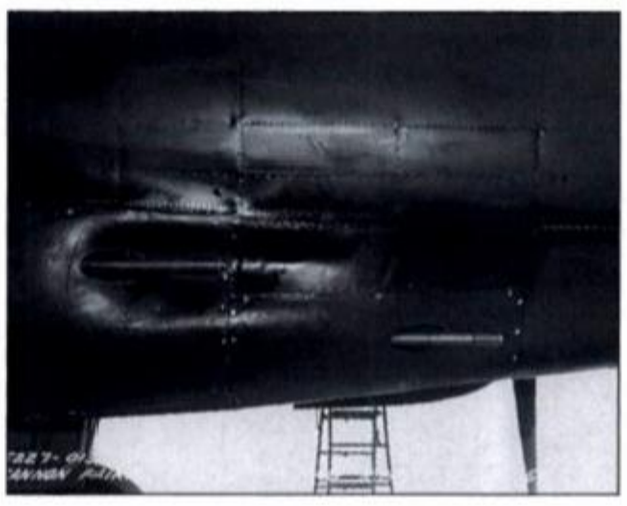

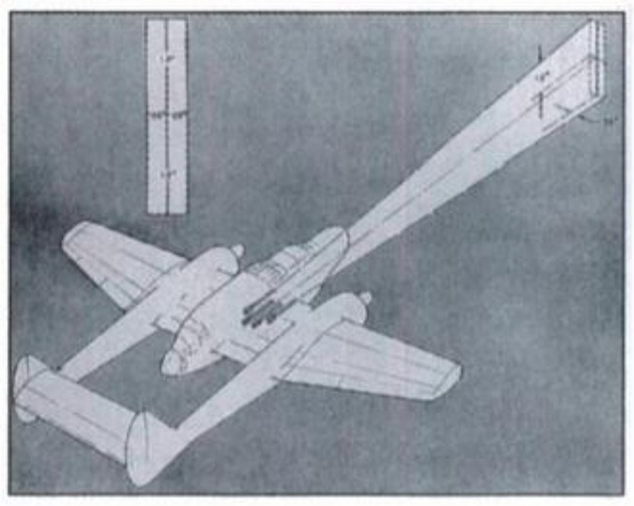

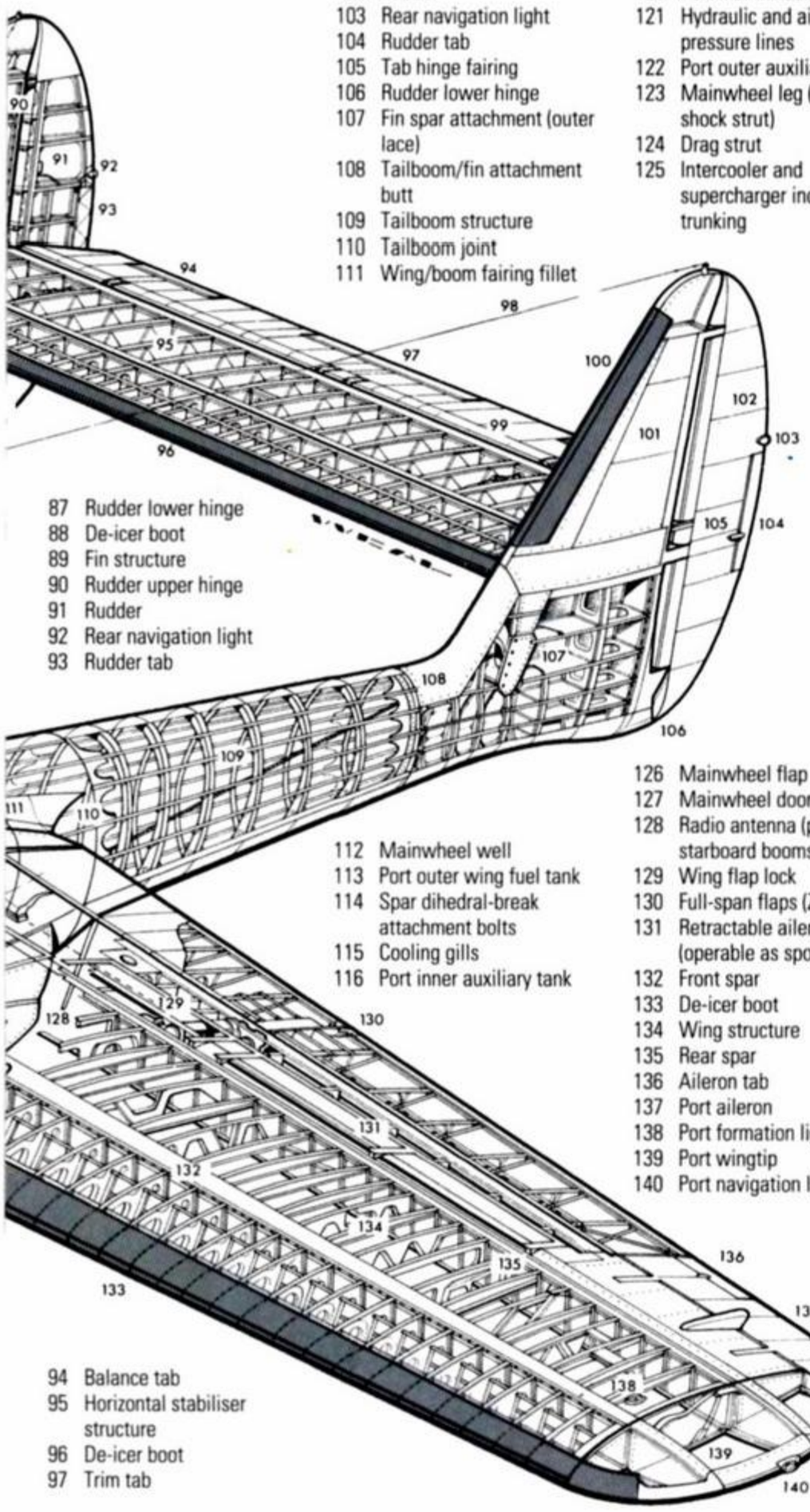

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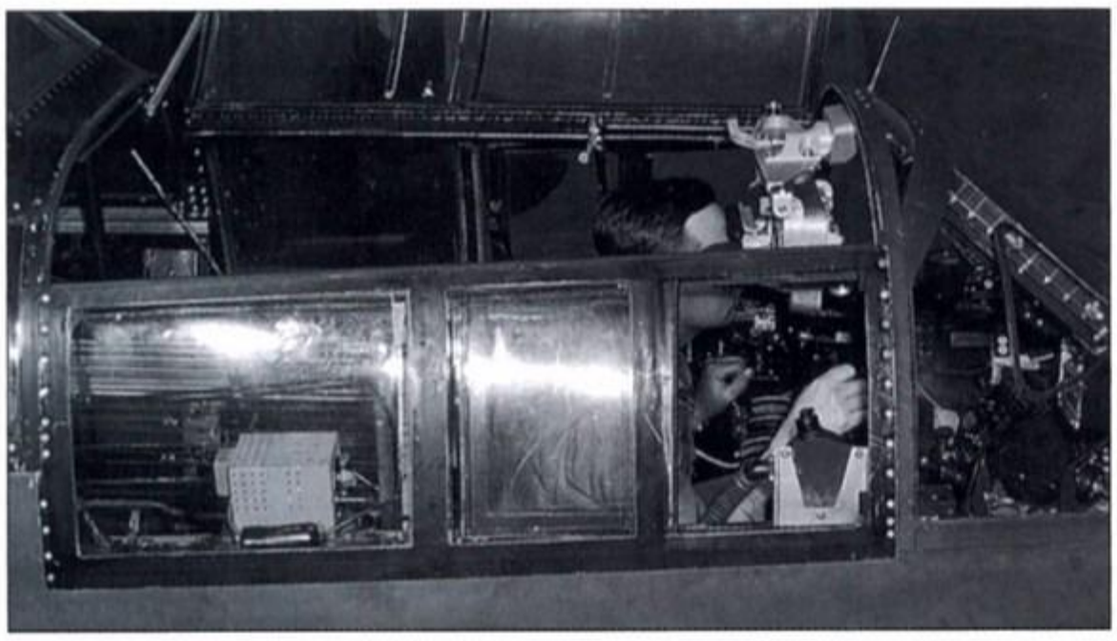
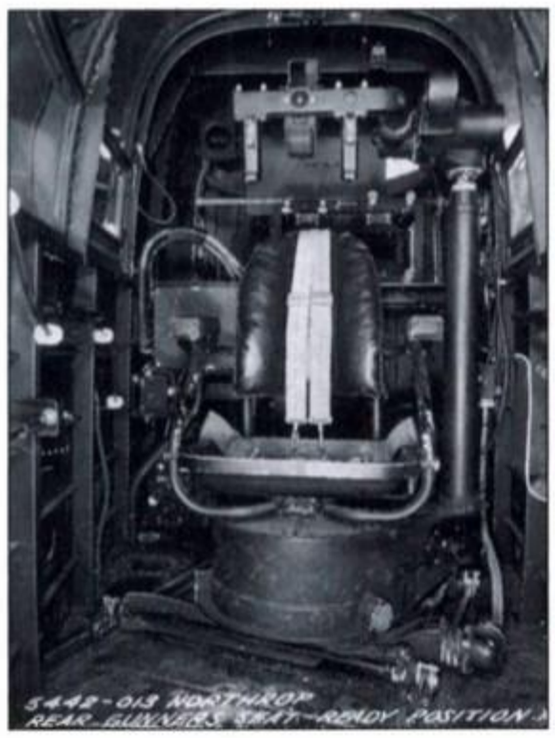
Performance: maximum speed 400 mph (708 km/h); service ceiling 41,000 ft (12497 m); range 4,000 miles (6437 km)

P-61 crew accommodation

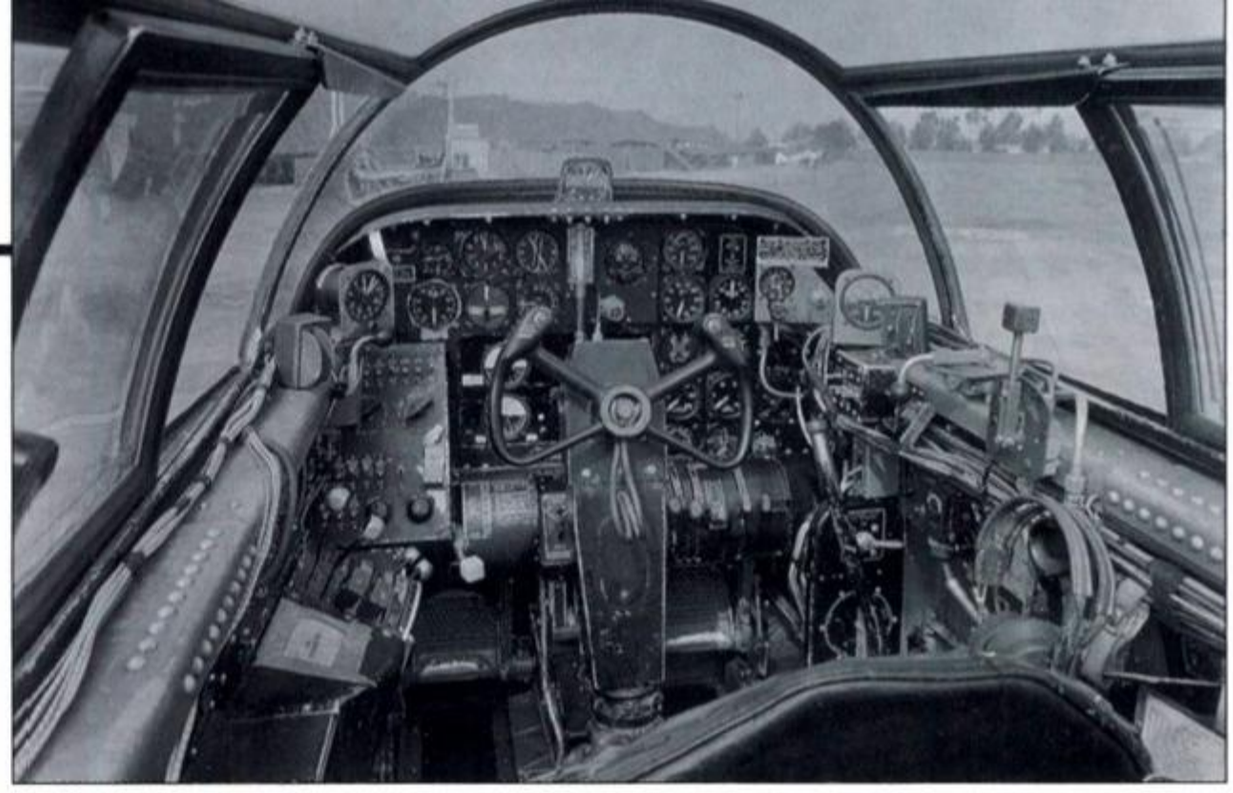




Above: Night binoculars, as used in the P-61B and C, combined a gun sight with 5.8x power night glasses. When in use, the sight presented the pilot with a row of illuminated dots which were lined up along the wing span of an enemy aircraft. When not in use, it was stowed behind the pilot.

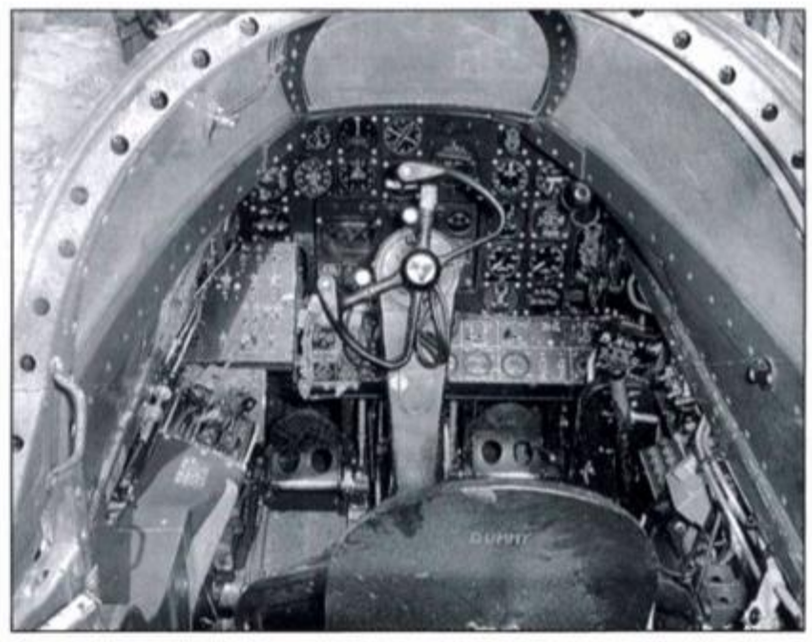
Left: In this view of the gunner's station, the sight is seen locked into position. In many of the P-61s without the top turret, the radar observer's station was moved behind the pilot as there was no need for a gunner.

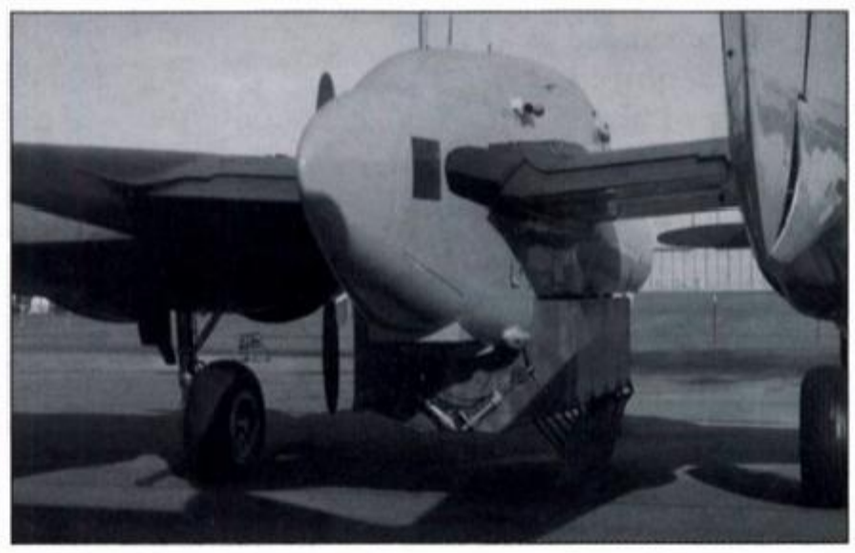
Right: The radar observer's position and SCR-720 equipment is seen here in the back of a 425th NFS aircraft, looking forward. The swivelling seat allowed him to aim and fire the turret guns, if necessary.



Above: This view of the pilot's station in XP-61 41-19509 was taken on 1 July 1943 at Northrop's California plant, over a year after the prototype made its first flight.

Right: The considerably narrower cockpit of the XP-61E is shown here. Its layout was completely changed, affording the pilot a much improved view through a bubble canopy. The radar observer was positioned behind the pilot, facing forward.

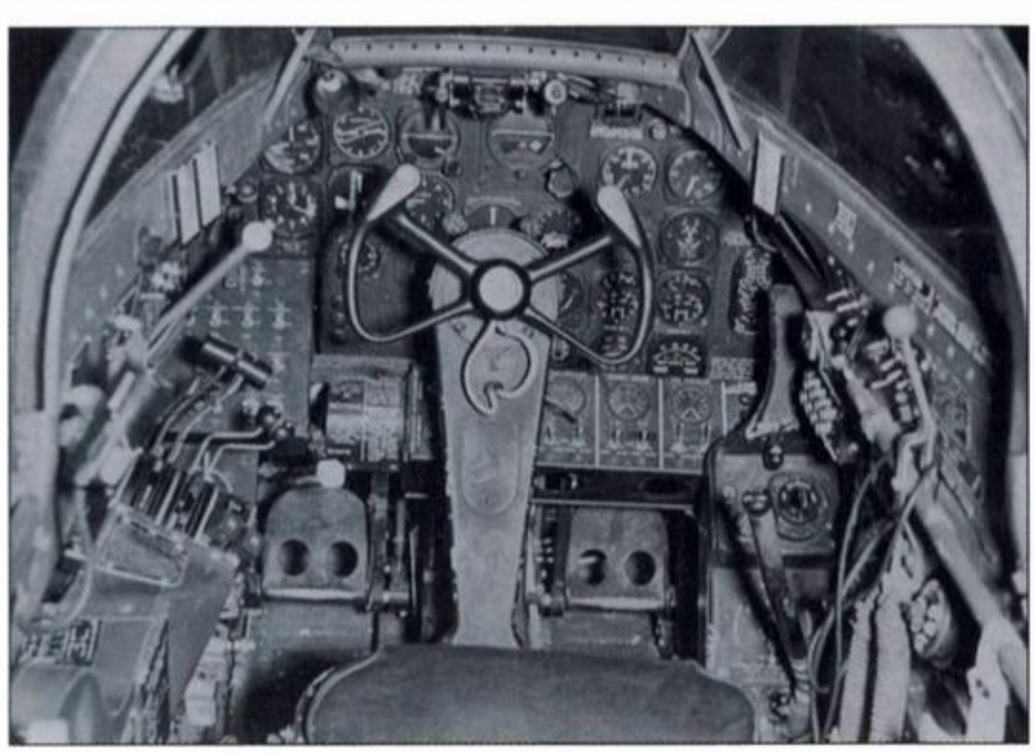


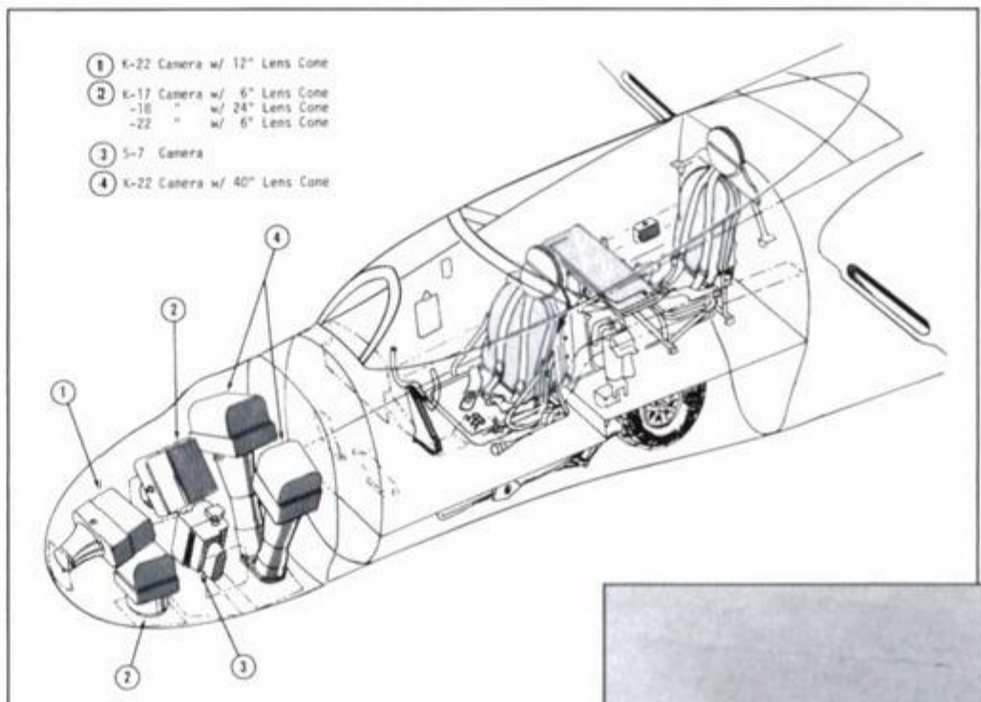


Converted P-61B fire-bomber N30020 sported a 1,600-US gal (6056-litre) chemical tank on the underside of the crew nacelle. Note that the Plexiglas panels to the rear and above the gunner's station have been painted over. N30020 is seen at Fresno, California prior to its 23 August 1963 crash.

F-15 cockpit and cameras

The cockpit of the F-15A Reporter may be compared with that of the XP-61E, from which it was derived. Though broadly similar, there are a number of layout differences. The F-15 was a dual-control machine, ideal for longer missions such as those from Japan. Tilting seats and an autopilot were additional aids for such flights.





Left: As many as six cameras could be crammed into the F-15A's nose. There were 24 possible camera arrangements utilising 17 different camera types. The cameras were controlled by the co-pilot/navigator from a panel on the left-hand side of the rear cockpit.

Right: This F-15 nose belongs to the prototype 42-39549, converted from one of the two XP-61Es. Clearly designed with the easy removal and replacement of camera equipment in mind, the camera compartment was installed in place of the P-61E day fighter's four 0.5-in machine-guns.

Black and white images often give the impression that the P-61 was a drab aircraft. This was certainly not the case with many late-war PTO aircraft, such as this 421st NFS machine with its yellow spinners and cowl flaps, red intake covers and aluminium drop tanks. The 421st was based on Ie Shima from July 1945.

The work day begins for a 6th NFS night-fighter crew as the pilot and R/O of* Midnight Mickey *walk toward their aircraft at dusk. The crew chief is cleaning off the canopies and the gunner is probably already onboard. This photo, taken in 1944 on Saipan, was classed as 'confidential' because the setting sun has silhouetted the secret radar dish inside its Plexiglas dome.

"At the insistence of the Army Air Corps, the final test was scheduled as a 'structural integrity demonstration'. This test required the pilot to apply maximum permissible airspeed at the critical Mach number, which dictated performing the manoeuvre at 17,000 ft. It was at this time I activated the brakes. When I applied back pressure on the stick to produce the desired *g*, I found the stick force had reduced to zero. The stick ended up in my lap and the last thing I recall is noting the accelerometer pegged at 10 *g*! The aircraft was greatly overstressed; both wings and empennage failed structurally, and separated from the aircraft. This produced negative *g* to the extent that I was pitched forward with such force that the pilot's seat pulled free from its attach points on the floor! My face struck the windscreen and my oxygen mask absorbed the effects of the blow."

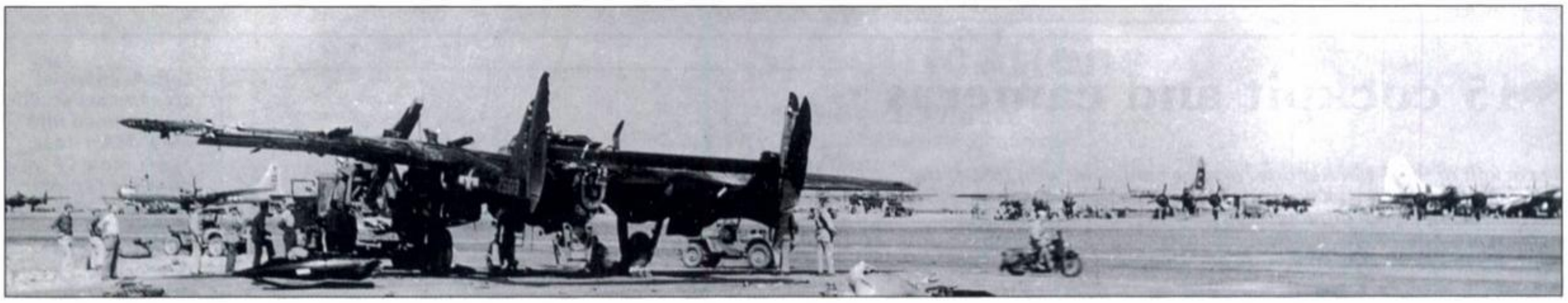
Stanley managed to unfasten the latch on the top of the canopy, allowing the force of the negative *g* to literally throw him from the remains of the aircraft. He was able to parachute to safety. Stanley adds, "Subsequent test flights on this proved that the basic cause of my experience was the phenomenon of compressibility, about which little was known at the time. No further tests were ordered and the subject of speed brakes on the Black Widow was a dead issue. At the time, the P-61s already coming down the assembly line had the speed brakes. They were rendered inoperative and bolted closed. This feature was never used in combat."

By late 1943, the production demands on Northrop for its P-61As and Bs left no room for other experimental modifications. All modification work on the two XP-61C airframes and the new engine installations was carried out at the Goodyear Aircraft Plant in Akron, Ohio. On 1 April 1944, XP-61C (42-5559), the first prototype, was accepted for testing, and 13 days later it was delivered. The second prototype (42-5587) was delivered on 3 May 1944. Both airframes had originally been assembled as P-61As, the first a P-61A-5 and the second a P-61A-10.

With the capture of Iwo Jima, the use of a long-range fighter (VLR) escort became a reality and the prospects for an impending invasion of Japan gave it top priority. To the basic Black Widow structure, Northrop engineers made a few changes in the crew nacelle, including fitting a bubble canopy and room for only a pilot and relief pilot/navigator. The four 0.50-in machine-guns were moved into the nose. With its big supercharged engines, it could easily take on anything that might challenge the B-29s.

Reconnaissance Reporter

Although Northrop had the night-fighter business sewn up during World War II, the competition for the long-range fighter was also entered by North American. At the same time, a new mission had cropped up calling for an aircraft similar to the Northrop XP-61E. This design would not carry guns, but would be loaded with cameras in the nose and be capable of photographing Japanese fortifications on Formosa and the Japanese home islands. It would be



***Four 548th NFS P-61s which had been working an early morning patrol near Iwo Jima were caught in a dense fog that covered their landing area.* Midnite Madness *flown by Capt. James Bradford made it in and blew a tyre. After coming to a stop, it was hit by the second aircraft,* The Spook, *flown by Lt Mel Bode. He bounced over the top of Bradford's* Black Widow, *writing off both of them. The crew of the third P-61 bailed out offshore and was rescued. The fourth aircraft had enough fuel to wait it out and landed safely. The top picture shows the remains of* Midnite Madness.

Northrop P-61B-1 Black Widow 418th NFS Philippine Islands July 1945

Black Black Widow
Painted overall in what was officially named Jet Black (ANA622) 'anti-searchlight' paint, this 418th NFS P-61 also wears the colourful unit markings introduced in early to mid-1945. A P-40 was used as a 'hack' with the same tail marking. The moon and star were symbolic of the unit's night role, and the tailband aligned – in heraldic terms, 'sinister' – was said to reflect the 'bastard ancestry' of the squadron, which was not assigned to a 'parent' fighter group. This unit usually carried only the last three or four of the serial as the radio call number, and full serial numbers were not recorded on combat reports, making identification of particular aircraft difficult. Safe areas for ground crew to walk on the wing, avoiding the many control surfaces and weaker skins, were delineated by red lines.

Top-scoring team
Major Carroll Smith was the top-scoring US night-fighter pilot, with seven confirmed kills. As CO of the 418th, 'Snuffy' Smith was able to fly any of the squadron's aircraft, which in 1944 included B-25s and P-38Js as well as P-61s. Smith scored five kills on the Black Widow, interspersed with two more and a probable on P-38Js. The radar operator for all of Smith's kills was 1st Lt Phillip B. Porter. Porter later became an F-82 R/O and was involved in one of the first air-to-air combats of the Korean War. Carroll Smith retired from the USAF as a colonel in 1970.

Turrets
The P-61s which entered service with the 418th from August 1944 were without turrets. Some replacement aircraft with turrets were received in January/February 1945. In early August, the new CO, Captain Sellers, had the turrets removed to increase range, with an eye on possible missions over Korea, and they stayed off when the squadron was based in Japan post-war.

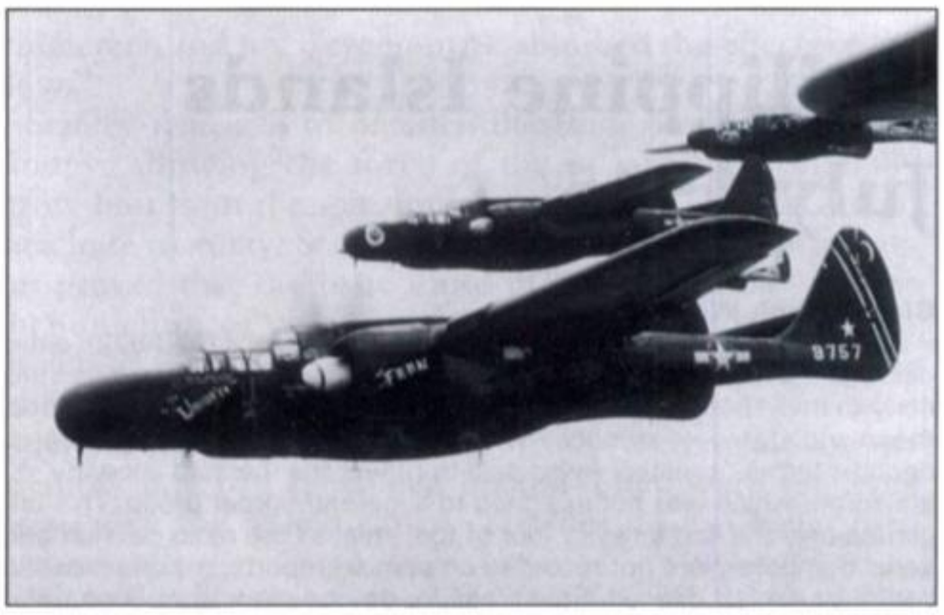
Snuffy Smith
The nose-art on Smith and Porter's P-61 depicts the comic strip hillbilly moonshiner Snuffy Smith from the strip *Barney Google and Snuffy Smith*. Several other US warplanes used this character and catchphrase. In this case, it was also a reference to the pilot's nickname.

Four in one night
Smith and Porter were the only US night-fighter team to score four kills in one night, December 29/30 1944. In two sorties, but without rearming, they shot down two 'Irvings', a 'Rufe' and a 'Frank' over a convoy off Mindoro with only 382 rounds (out of 800) of cannon fire. The last of these was caught after sunrise and disintegrated by a burst of 20-mm fired from below and behind at a range of just 75 ft (23 m).

Time's-A-Wastin'
Although sources differ, there appear to have been two 418th NFS P-61s named *Time's-A-Wastin'*. Smith and Porter's kills were probably scored in the first *Time's-A-Wastin'*, a turretless P-61A marked '595', (probably 42-5595, a P-61A-10). Turreted P-61s arrived with the 418th only in the last weeks of Smith's tour, which ended in mid-February 1945. This aircraft, '403', carries all seven kill markings, but these could have been transferred to a replacement aircraft along with the nose-art.

Mixed force
When based at Morotai from September 1944, the 418th operated a mixed force of three types – P-38Js were used on searchlight cooperation over the airfield, B-25Hs were used as night intruders with APS-4 radar and the P-61s flew barrier patrols against the frequent night raids. Later, the P-38s were modified locally with SCR-540 radar taken from P-70s and a radar observer was crammed into a jump-seat; although the installation worked, little success was achieved. Overall, the squadron destroyed 20 Japanese aircraft, all but two with the P-61, and was also credited with three probables.

Lt Roland T. Fisher stands by the wreckage of a Japanese transport that had been loaded with enemy troops. They attempted to land on Tacloban airstrip in the Philippines, right after dusk, for a suicide attack against the aircraft and crews on the strip. An alert 40-mm AA gunner spotted the unique exhaust pattern and shot down the aircraft, which crash-landed in the middle of a row of Marine Corsairs. Over 40 Americans were killed or wounded in the incident. The P-61 in the background belongs to the 421st NFS. The bodies of Japanese troops can be seen on the ground.



Above: A flight of 418th NFS Black Widows is led by P-61B-15 **The Wanda'er** *with full unit markings and coloured spinners with a spiral. Colourful markings began to appear before the war's end on Pacific Widows, unlike in the ETO.*

Left: This clever sign was posted in front of the operations building on Zamboanga courtesy of the US Marines' MAG-12. A detachment of the 419th NFS was assigned to the Marines for a short period, to protect their base at night.

manned by two pilots, with one capable of navigating and operating the cameras. The original projection by high command was for 320 such aircraft, later trimmed to 175. This photo-ship would be known as the Northrop F-15 Reporter. Of all the outgrowths of the Black Widow which were seriously considered after the P-61B models, only the F-15 (RF-61C) saw significant post-war production and was also used in a front-line squadron by the US Air Force.

The XF-15 prototype was one of the two converted XP-61Es, the original airframe having been P-61B-10 42-39549. The E model had been set up with 0.50-in guns in the nose, but this configuration was quickly changed and a series of cameras was installed. They would shoot straight down, forward and obliquely, and be controlled by the crew member sitting aft of the pilot. The second photo-reconnaissance ship to be converted by Northrop was originally a P-61C-1. The assigned AF serial number was 43-8335, and it was designated the XF-15A.

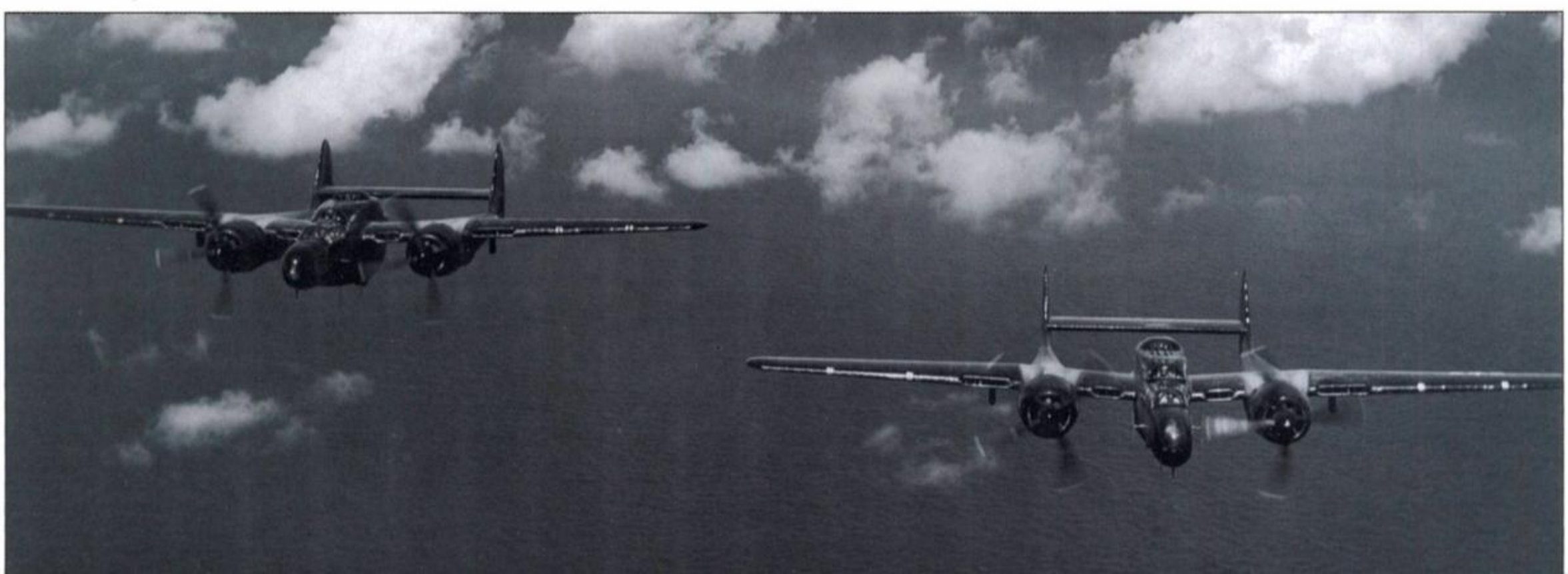
A pair of P-61A-11s, probably of the 548th NFS, prowls near Saipan in January 1945. The following month, the 548th was joined by the 549th, fresh from Hawaii. The busiest period for these two night-fighter squadrons came in June, when they were based together on Iwo Jima. The 548th scored three kills and one probable in this month, and the 549th made its single confirmed victory.

Sudden end to war – and production

World War II ended rather abruptly. Right up to the dropping of the second atomic bomb, military planners were still thinking 'invasion'. The geared-up production in US factories came to a grinding halt. Orders for aircraft were cancelled by the thousands. Although Northrop took a hard jolt as production of P-61Cs halted, all was not lost. The F-15 was one of only a few contracts left open, but with a greatly reduced production run of 36, compared to the 175 originally ordered. Six months after the war ended, the AAC determined that the F-15 could be used to photo-map the Pacific region's islands, something which had not been done. It would be the perfect opportunity to put to good use the state-of-the-art camera equipment installed in the F-15.

The opening description printed in the official F-15A Pilot's Handbook, dated 15 July 1946 – which was in effect until the first and only revision was printed on 10 October 1949 – states, "The F-15A is a two-place, long-range, photographic reconnaissance aircraft, powered by two Pratt & Whitney R-2800-73 turbo-supercharged engines. It has a wing span of 66 ft, a length of 49 ft 6 in and a height of 14 ft 3 in. The normal gross weight is 32,093 lb and the maximum gross weight with all four 310-US gal drop tanks installed and filled to capacity is 40,454 lb. The crew consists of a pilot and a co-pilot. The co-pilot is also the photographer and navigator."

Had the invasion of Japan taken place and the Pacific war been extended another year, the long-range Northrop reconnaissance version of the P-61E might have reached its original projected production total. It had a top speed in excess of 400 mph (643 km/h) and, with all external tanks utilised, its range would have been over 4,000 miles (6437 km). The entire Japanese homeland would have been easily reachable from Iwo Jima or bases in China. Also, the long-range fighter escort duties would have been handled by the P-61E or the P-82 Twin Mustang. Of course, this is all speculation.



During the final few months of the war, the 550th NFS had numerous detachments at bases in the Philippines. **The Prince,** *shown here on one of the islands alongside a B-17 and an F-5G, was assigned to Lt Russ Lortz.*

The operational use of the Reporter would be handled by only one squadron, the 8th Photo Reconnaissance Squadron attached to the 35th Fighter Group at Johnson AB, Japan. The squadron had been reactivated in the spring of 1947, although it had no assigned aircraft at the time.

By the middle of May 1947, Northrop was ready to ship some F-15As to the Far East. On 24 June 1947, the 8th received the call to send a couple of pilots to Kisarazu Air Base to pick up two new Reporters which had been reassembled and were ready for the squadron. These two pilots were Lieutenant Virgil Heistand and Captain Rowan Jarvis. The F-15's days of glory had arrived, though it only had short time to take advantage of them because the appearance of new jet reconnaissance design from Lockheed – the RF-80A – was imminent.

The squadron kept a small detachment at Kisarazu to assemble the aircraft as they arrived from the US, at a rate of four per month. By 30 August 1947, the 8th had 10 operational aircraft, far short of its full complement. The first official photo mission was flown from Johnson AB in late July, with Captain Wilmer H. Moore at the controls.

P-61 kills in World War II (by major command)

Pacific Theatre of Operations

5th Air Force		
418th NFS	18 confirmed kills	3 probable kills
421st NFS	13 confirmed kills	1 probable kill
547th NFS	6 confirmed kills	0 probable kills
7th Air Force		
6th NFS	16 confirmed kills	2 probable kills
548th NFS	5 confirmed kills	1 probable kill
549th NFS	1 confirmed kill	0 probable kills
13th Air Force		
419th NFS	6 confirmed kills	1 probable kill
550th NFS	0 confirmed kills	0 probable kills

European Theatre of Operations

9th Air Force		
422nd NFS	43 confirmed kills	6 probable kills
425th NFS	10 confirmed kills	1 probable kill

Mediterranean Theatre of Operations

12th Air Force		
414th NFS	5 confirmed kills	0 probable kills
415th NFS	0 confirmed kills	0 probable kills
416th NFS	0 confirmed kills	0 probable kills
417th NFS	0 confirmed kills	0 probable kills

The 415th, 416th and 417th NFS flew Beaufighters and Mosquitos for most of their combat tours so had no kills in the P-61.

China-Burma-India Theatre of Operations

10th Air Force		
427th NFS	0 confirmed kills	0 probable kills

(427th served under both 10th and 14th Air Forces)

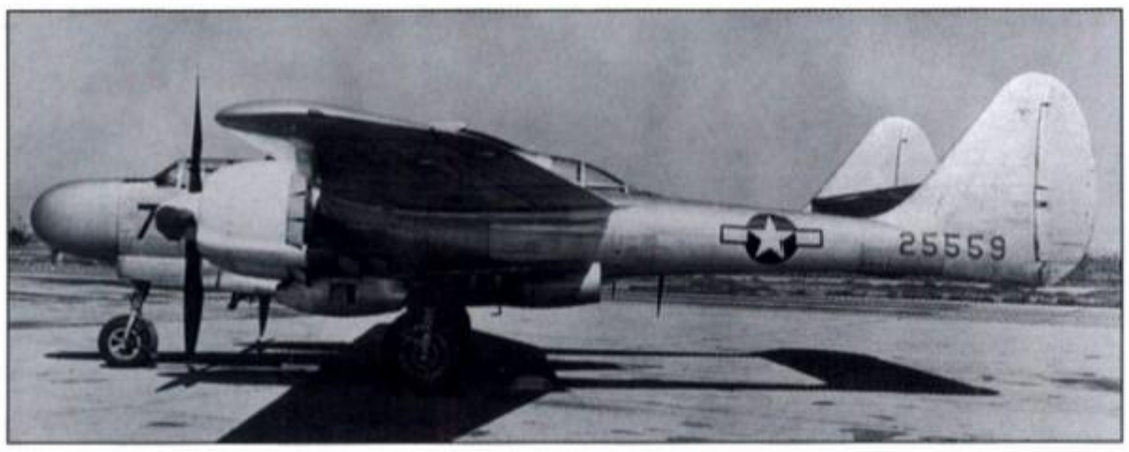
14th Air Force		
426th NFS	5 confirmed kills	1 probable kill

The assigned crew of* Lady In The Dark *stands below the famous nose-art on their P-61B on Iwo Jima. Left to right: R/O Lt John Scheerer; crew chief Sgt Matthew Lux; pilot Major Lee Kendall; and gunner S/Sgt. James Skiles. In the hands of two crews,* Lady *scored the last air-to-air kills of World War II.

When the war ended, the 6th NFS began putting large numerals on the noses of its Black Widows for identification. P-61B '13' was flown by Lt Jack Hahn from Wheeler Field in Hawaii. This photo was taken in late 1945.

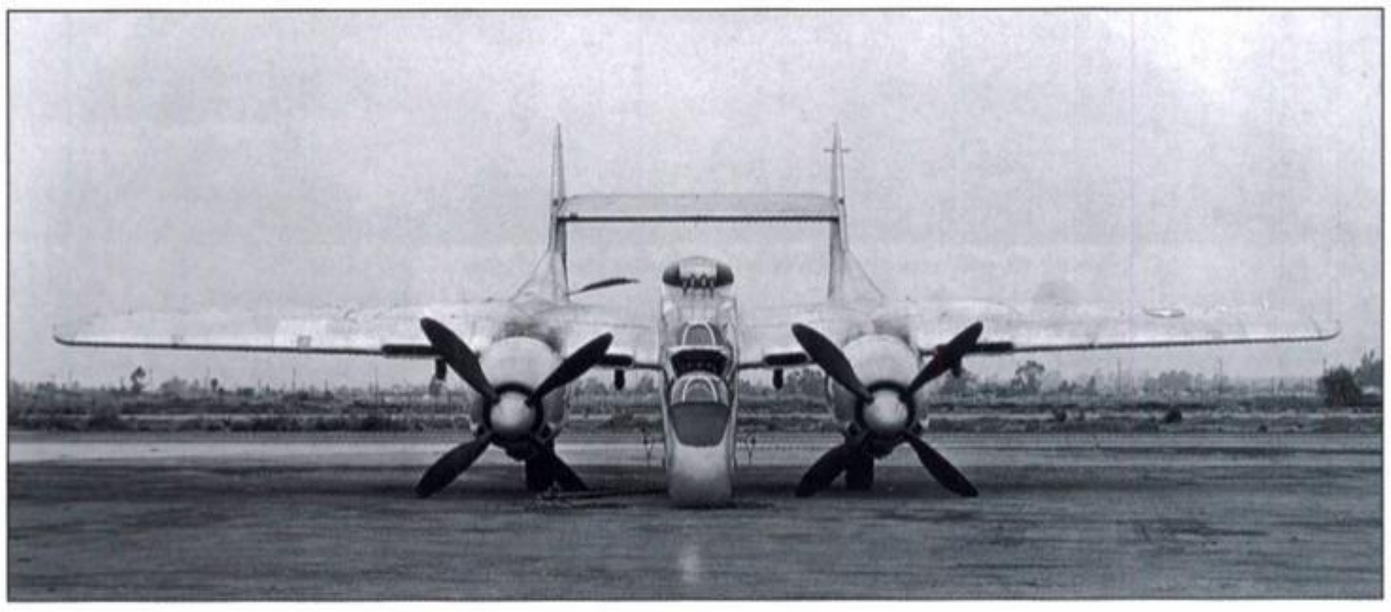
Northrop P-61 Black Widow

Two prototype XP-61Ds were built. Ship '791' was converted from P-61A-5 42-5559 and '819' was originally P-61A-10 42-5587. Both of the D models were powered by the big Pratt & Whitney R-2800-77 engines, which could put their top speed above 400 mph (644 km/h).



XP-61D

The two aircraft that were to become the XP-61Ds were originally designated XP-61Cs as part of the programme to produce an improved, supercharged P-61B. The XP-61C work was mainly contracted out to Goodyear of Akron, but difficulties there delayed the first flight until November 1944. Meanwhile, Northrop's idea of what the P-61C should actually be had changed, and the two aircraft were redesignated XP-61D to distinguish them from production P-61Cs.



Above and above right: The second XP-61D, '819', suffered nose gear failure while sitting on the ramp on 12 May 1945. Fortunately, the propellers were not turning and the damage was minimal. Before the XP-61D's eventual first flight, three different sub-types of engine were fitted to the aircraft.

The time-consuming job of photo-mapping a vast area of the Far East was about to begin. The 8th's new commander, Lieutenant Colonel Benjamin K. Armstrong Jr, led the planning sessions to deploy a few F-15A detachments to begin the squadron's assignment. This began in September, with three Reporters sent to Itazuke Air Base. The missions they flew were lengthy, some lasting seven hours. The work load for covering this western end of Japan was demanding, but the job was finished by December and the detachment returned to Johnson AB. There had been no incidents or mishaps, and, while they were gone, the 8th PRS had been brought to its full complement of 16 aircraft. In the 21 months during which the squadron was active, the number of F-15s in its inventory never exceeded 18.

Philippines sojourn

The winter of 1947/48 in Japan was harsh. The squadron's duties were suspended for almost two weeks in January due to bitter cold, snow and lack of spare parts. When the weather lifted, the extra F-15s in storage at Kisarazu were cannibalised for parts and things returned to normal. A few crews were able to get some relief from the cold when orders came down that at least five aircraft were to move to the Philippines to begin photo-mapping that area. The staging centre would be Clark Air Base and Captain Stanley Alukonis led the detachment. The assigned area included all of the Philippine Islands, south to the Celebes. They wasted no time in getting to the task at hand, and from 1 to 15 February they logged at total of 114 hours. This achievement got them a commendation from the commanding general of 13th Air Force.

Lieutenant Anthony Linkiewicz, a pilot in the 8th, recalls that part of their work in the Philippines took on a special meaning. "One of the most memorable photo missions I can recall was when I flew the route of the Bataan Death March. It seems that the prosecution in the War Crimes trials had requested it. The Japanese officers involved in this march stated that there was no water in that area for them to have given any to the prisoners. The trials were being held in Tokyo at that time. The pictures did prove that there was water on the route and I hope this information was put to good use by the War Crimes prosecutors."

In the meantime, another detachment had been sent to South Korea. Due to inclement weather and a few mechanical problems, this photo-mapping assignment dropped behind schedule. There was talk of splitting the Philippine detachment to help, even though the five F-15s operating from Clark had not finished their work in the Celebes Islands; in the end, the Clark detachment was allowed to complete its assignment. At this time, no one realised that the work being done in Korea would be absolutely critical in two years: when the Korean War broke out, these photo maps were the only ones of the South Korean peninsula.

Although the F-15s were relatively new aircraft, they received a lot of wear and tear but, given the state of the flow of spare parts to the Far East, they survived in fair shape. The F-80As had the priority, and the Air Force paid little attention to the weary propeller aircraft; even the F-51 Mustangs received no special treatment. Two Reporters were lost in 1948 due to engine fire or loss of power on take-off, with no fatalities.

In early August, the squadron learned that it would no longer be known as a Photo-Reconnaissance Squadron, but rather the 8th Tactical Reconnaissance Squadron (Night Photo). Two weeks before this change took place, the F-15's designation changed to RF-61C. Neither change made any difference to the way the squadron did business, and, considering that the photo-mapping mission was winding down, the aircraft's future did not look rosy.

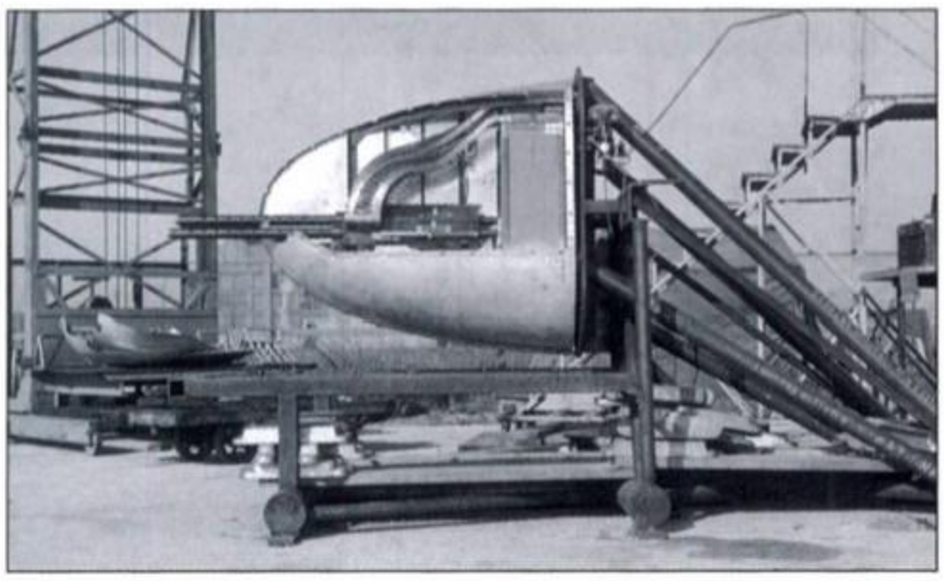
Immediately after Labor Day in September 1948, all detachments still working were called back to Johnson AB. Five aircraft scattered over the Philippines immediately

Photographed at Naha on Okinawa in 1946, this Widow shows the effects of two years' exposure to the Pacific sun and salt air. Poor quality control at Northrop led to quick deterioration of the paint on many P-61s.

Originally a P-61B-10, this aircraft was the first prototype of the long-range fighter escort XP-61E. It is shown at left over Los Angeles and, below, over the mountains of northern California during early testing. After the P-61E project was scrubbed, it became the XF-15 – prototype for the F-15A Reporter.

XP-61E day-fighter

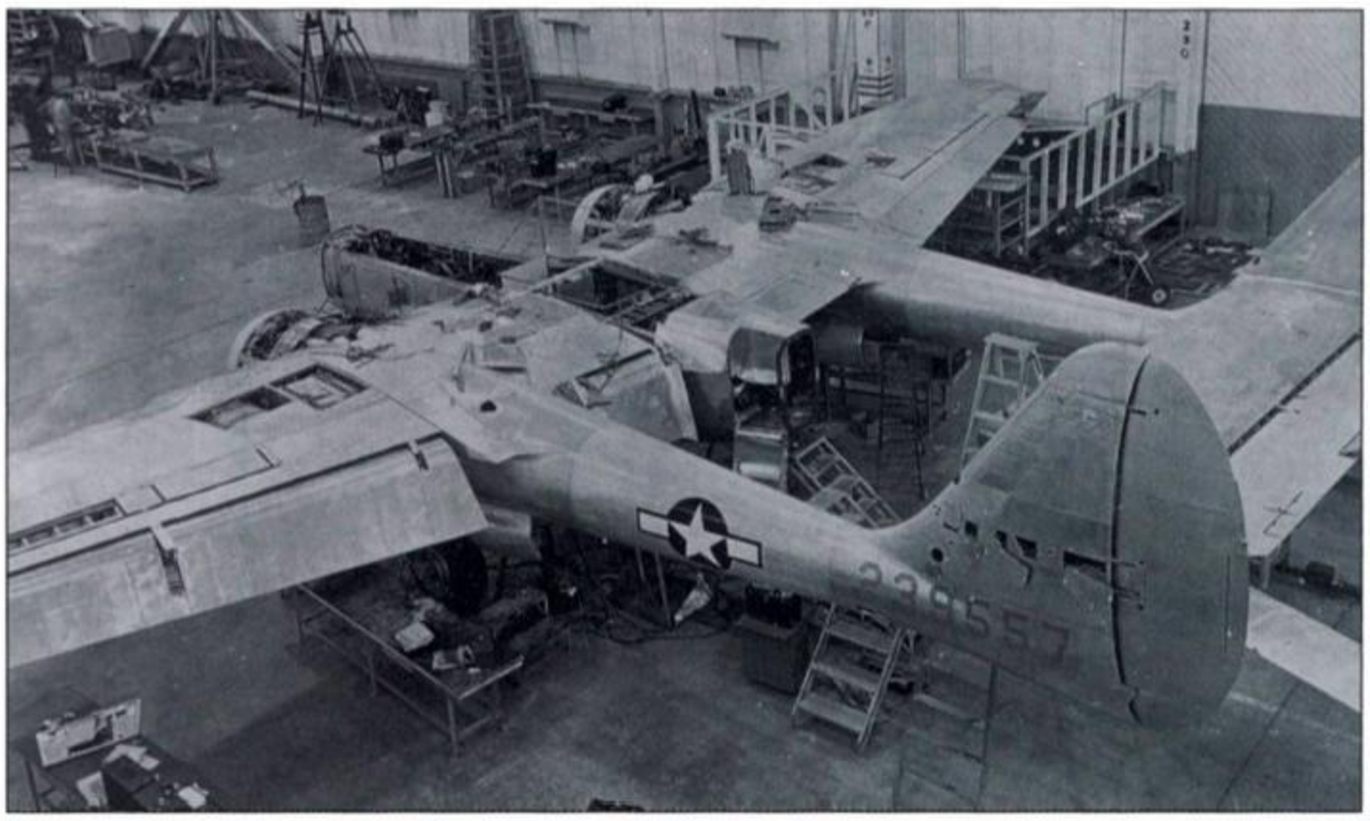
The XP-61E is said to have been developed following a discussion between John Myers and Brigadier General Paul Wurtsmith, CO of V Fighter Command. The 5th AF urgently needed a long-range escort for B-29 raids on Japan and Myers's proposal and sketch of a modified P-61 met with enthusiasm from the General and, soon, from Air Material Command. Within six months, two P-61Bs were being modified with a new nacelle and gun nose. The war, however, ended sooner than expected, and the project was cancelled in favour of the more modern P-82 Twin Mustang.



The configuration of the guns in the nose of XP-61E no. 2 is tested on the firing range at the Northrop plant. The second prototype was easily recognised by the four-abreast layout of the 0.50-in guns. This aircraft also had a sliding, rather than side-hinged, canopy.

headed home after an overnight stop at Naha AB, Okinawa. When all aircraft had been corralled, their assignments tapered off considerably.

However, some work did crop up from time to time. Lieutenant Tony Linkiewicz recalls when they were called in to conduct an aerial search around Mount Fuji. "A C-47 had encountered extreme turbulence while flying over the



This factory photo shows the second XP-61E undergoing its conversion from P-61B configuration at Northrop.

mountain, and had crashed on one of the slopes. Rescue crews on the ground could not locate the wreckage due to the weather conditions. At any rate, we mounted an oblique camera with a 24-in lens and shot a mosaic of Mount Fuji, which located the wreck. After we got the pictures to the rescue party, they went straight to the crash site."

An end to photo-mapping

On 25 March 1949, it all came to an abrupt, but not unexpected, demise. The 8th was transferred to Yokota AB where it became attached to a B-26 unit. The RF-61Cs were assigned to the 35th Maintenance Squadron at Johnson, where they were towed into the grass to await their fate. By this time, all the Reporters were in a poor state of repair, the normal channels for obtaining spare parts having dried up some time ago.

Lieutenant Charles Russell, a pilot in the squadron, recalls those last days. "Our old F-15s were parked on the north end of the ramp at Johnson. This was known as fly-away storage and they remained here for at least a year. At that time, they were flown over to Tachikawa and chopped up. There were practically no pilots left in the area who had experience in them. I remember they were in terrible shape. The gear wouldn't come up on one, so I just flew it

The ill-fated second XP-61E suffered fatal structural damage in a test flight on 11 April 1945. The aircraft started its take-off roll at full throttle and lifted off the runway in short order, with the pilot immediately pulling up the gear. The aircraft settled back down just enough to catch the propellers and slam hard onto the paved runway. The pilot was not injured but Northrop's long-range escort fighter programme was severely set back.

A pair of P-61B-20s from the final batch of B models gets airborne from a field in Europe. The 415th, 416th and 417th were the three squadrons assigned to US Air Forces Europe.

A cockpit fire of unknown origin did extensive damage to this 449th All Weather Squadron P-61B while it was parked on the ramp at Adak AFB in Alaska, circa 1947. The 449th was tasked with the air defence of the extreme northwest sector of North America.

Below: **Black Magic**, *a P-61B-16, gets moving at a post-war open house. It wears the 'PK' buzz-code introduced in late 1945.*

over with the gear extended. After landing, I taxied over into the grass and parked them.

"One of the last ones that I flew out had engine problems and I had to abort the flight. I landed and taxied back to the hangar to let the mechanics look it over. Suddenly the engine caught fire and, in spite of all the fire-fighting equipment that worked on it, the ship burned to the ground. The flying time to Tachi was only about 15 minutes and, if my memory serves me right, all of this took place back in the spring of 1950."

The RF-61Cs lasted until almost the start of the Korean War; they had stretched themselves into the jet age and had achieved their assigned objective. Their photos of Korea were invaluable to the UN forces during the first few weeks

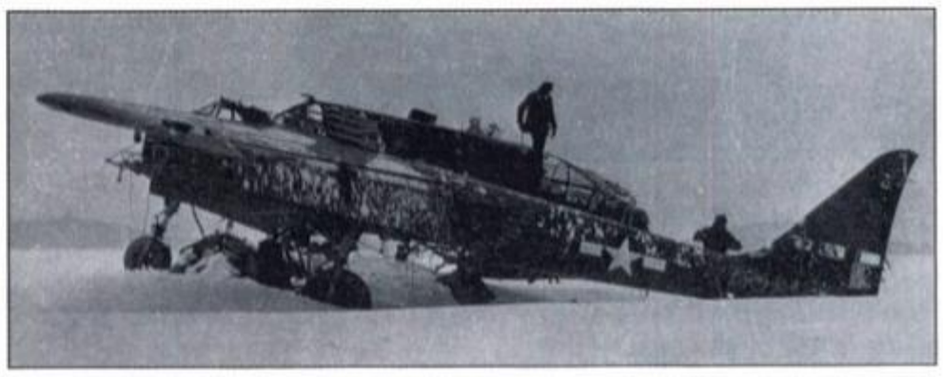
Out to pasture

All-weather operations immediately after World War II were the responsibility of a handful of Black Widows. At the time, the threat was not seen as significant and the requests for spare parts fell on deaf ears. By 1948, the flow of needed spare parts for the ageing P-61 had completely dried up. Most of these aircraft were soon bulldozed into a pit and buried. The airframes were not considered to be worth shipping back to the US, but today they would be worth millions of dollars.

One of the rare YP-61s awaits its fate at the 'boneyard' at Tucson in 1949. The aircraft looks well cared for, with tie-downs, engine covers and protective coating on the canopies.

Less fortunate, the 12th YP-61 sits exposed to the elements at a desert 'boneyard', time and place unknown. Covers would not have prevented its inevitable demise.

Five old 548th NFS aircraft sit parked at Clark, where they had been shut down three years previously. The long-range fuel tanks are still in place after their long flight from Ie Shima. None of these aircraft survived past 1950.



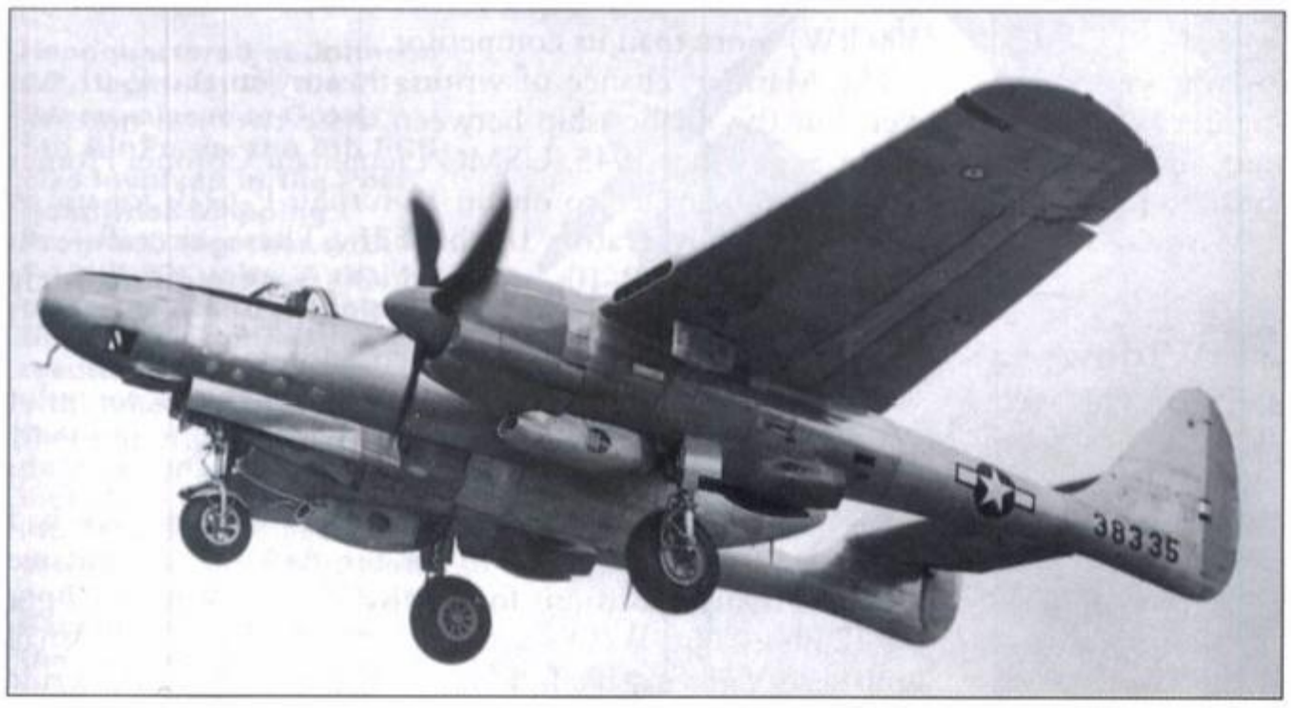
In Europe, the fate of the P-61 was much the same as in other areas. This stripped P-61 lies in a salvage yard at Horsching Air Base during the winter of 1945/46. It had probably been assigned to the 416th NFS, which was at Horsching at the time of its inactivation.

One of the 4th AWS maintainers removes necessary parts from this former 548th NFS Black Widow, to be taken back to Naha AB, Okinawa for its own P-61s.

F-15 Reporter

Despite failing to win a production order for the P-61E, Northrop was able to adapt the design for the long-range reconnaissance role. The resulting XF-15 found favour and 175 were ordered in June 1945, the prototype first flying on 17 October that year. Deliveries began in September 1946, but several factors, including the advent of jets such as the RF-80, led to the cancellation of the contract in 1947. Total production amounted to only 36 airframes, along with two prototypes. Production of F-15As mostly utilised parts already produced for the P-61C, cancelled in mid-1946.

Above: The XF-15 (42-39549) was converted from the first XP-61E, which in turn was a conversion from a P-61B-10. The aircraft was refitted with a sliding canopy as on the second E.



Above, left, and above left: The second Reporter was designated XF-15A and was converted from a P-61C. The Reporter airframe was basically a P-61C with a new crew nacelle and camera nose, although the fighter brakes of the P-61C were deleted entirely from the F-15A. Production of the nose was sub-contracted to the Hughes Tool Company of Culver City, California.

of that war. It was not until the Marine photo version of the F7F Tigercat made its sweeps over Inchon that any additional pictures were taken.

When World War II ended, there was a distinct void in the all-weather capabilities of the Army Air Corps. Only one aircraft had been designed for and assigned this mission during the war, and had handled the assignment so well during its brief period of combat that no other all-weather fighter types were ready to take it on. So, until something better was designed and produced, the Black Widow was it.

For the continental United States, one major All Weather Fighter Group would be assigned to each coast: the 52nd would handle the East Coast and the 325th would take the West Coast. A third Group (the 347th) would cover a vast area in the Far East from former enemy bases on the Japanese mainland, including Atsugi and Itakuze.

The heavy maintenance and lack of spare parts caused the P-61s to become very difficult to keep in the air. Some crewmen commented that their aircraft "were held together with baling wire". The development of a jet fighter able to perform the night-fighter/all-weather role was slow, so the P-61 stayed around longer than it should have before finally being relieved by the North American Twin Mustang.

During the course of World War II, the night-fighting

The only unit to operate the F-15A was the 8th PRS, headquartered at Johnson AB, Japan. The winter of 1947/48 brought some bad flying weather around Johnson AB and, since the 8th PRS needed relatively good weather to take pictures, it was not required to fight the elements on days like this.

Above: The canopy of the F-15 was the largest single piece of blown Plexiglas manufactured at the time. It provided exceptional visibility, as can be seen in this view of the prototype about to embark on a test flight.

Above and below: These F-15As are part of detachments operating from Clark AB in the Philippines, 1948. Usually, they worked in two-ship units when away from their main base. **The Missing Link**, *below, which was assigned to Tony Linkiewicz, was the only known named Reporter.*

Lieutenants John Biddle and Stanley Walden take time off from their rigorous photo-mapping schedule to enjoy the antics of someone's pet monkey. This photo was taken in a very remote area on Mindanao in 1948.

work of the US Navy and Marine Corps was very good, despite not having a purpose-built night-fighter type. Their front-line aircraft included the PV-1 Ventura and the radar-fitted F6F Hellcat and F4U Corsair, the latter two not arriving until fairly late in the war. The Marines' veteran night-fighter unit was VMF(N)-531.

The Marine Corps and the Black Widow

The Navy showed a keen interest in the P-61. This went so far as agreeing to obtain 75 Black Widows from Northrop, with the operational responsibility falling to the Marine Corps. These aircraft were intended for delivery between July and December 1944, but complications arose in the form of Grumman and its night-fighter version of the F7F Tigercat. As time drew near for the Marines to start taking delivery of its first Black Widows, the contract was abruptly cancelled by the Navy. The reason was obvious: the F7F-3N was ready for production and its statistics were very impressive. The F7F was capable of 513 mph (825 km/h) at 40,450 ft (12330 m), compared to 430 mph (690 km/h) at 41,000 ft (12500 m) for new versions of the Black Widow. The Tigercat developed about 400 hp (300 kW) more than its competitor.

The Marines' chance of writing history in the P-61 was over, but the relationship between these two was not over yet. In September 1945, USMC Lieutenant Colonel Homer Hutchinson managed to obtain 12 surplus P-61Bs for use in training radar operators in the F7F. These aircraft – an assortment of P-61B-10s, -15s and -20s – were immediately delivered to the Marine Night-Fighter Operational Training Detachment at Vero Beach, Florida.

Captain Paul Noel was a night-fighter instructor pilot with the Marines at Vero Beach. He explains why the P-61 was so important at that time. "The Black Widow was used as an airborne trainer for Marine radar operators. We had airborne classrooms in a C-45 for the APS-6 radar but we needed a flying classroom for the SCR-720. When we got the 12 ships, the R/O's seat was removed and two small jump seats were installed. This allowed an instructor to ride with the student. The Plexiglas was covered with white wash, so there was no outside view. You could imagine being buttoned up in the back of a P-61, not being able to see out, the Florida heat and no ventilation.

"There is an interesting anecdote about the Black Widow's designation in the Corps. After they were delivered to Vero Beach, it came time for the first monthly report to be turned into the Navy Bureau of Aeronautics. I did the report; flight time, etc. I had to put down the aircraft's designation number, so I figured it had to be FT-1. Eventually, we received a correction from the Bureau, stating that there had been an FT-1 many years prior, so the new number for the P-61 would officially be the FT-2.

"If I had a choice of flying combat in the F7F or the P-61, I would have chosen the F7F simply because it was faster."

The P-61s' time with the Marines was short-lived. They

Below right: One of only a few air-to-air pictures of an operational F-15A in flight was taken from the no. 2 of a two-ship formation headed back to Clark AB from a photo mission over the Celebes. The aircraft had formed a detachment from the 8th Photo Recon Squadron that was working the many islands of the Philippines in 1948.

Bottom: Captain Stan Alukonis, commanding officer of the 8th's detachment at Clark, eases his F-15 in for a landing after a mission, February 1948. Mt Pinatubo, which later destroyed Clark AB in the 1990s, is in the background. His unit ranged as far south as Borneo and Celebes, and some of the photo-mapping they did then is still used today.

Crew accommodation
The F-15A was built for a crew of two, seated on reclinable seats under a large single-piece canopy. The rear seat was fitted with basic flying controls, allowing the occupant to relieve the pilot if needed. The backseater controlled the cameras and navigated the aircraft, but both crew members were rated pilots and trained in the reconnaissance tasks, so they usually alternated position on each flight.

Northrop F-15A-5 Reporter 8th PRS 71st Recon Gp Itazuke, Japan 1948

Headquartered at Johnson AB, Japan under the 71st Reconnaissance Group, 5th Air Force, the 8th PRS was involved in the Post-Hostilities Mapping Program, together with F-13 (B-29) units. A major task was photo-mapping the Korean Peninsula, the results of which proved vital when war broke out there in 1950. A detachment of F-15As, including this aircraft (45-59323), was assigned the area of the Philippines and Celebes under the 5th Reconnaissance Group of the 13th Air Force, and their mission included mapping the route of the Bataan Death March for war crimes prosecutors.

F-15A-5
With only 36 production Reporters completed, few improvements were introduced on the line. The first 20 examples were F-15A-1s and the remainder were A-5s with some modification to the camera installation and operation.

Production
Of the 36 F-15As produced, nine were allocated to Air Material Command in the US, and the other 27 were shipped to the 8th PRS in Japan. At least three arrived in such a poor state that they were reduced to spares, and two were written off in service. The remainder were flown into storage at Tachikawa and most were scrapped, a small number returning to the USA. After limited use by NACA and in Project Thunderstorm, the Reporter (and the Black Widow) were declared obsolete in 1952. One aircraft joined the civil register and survived until 1968, when it was lost in an accident while fire-bombing.

Cameras
Up to six cameras of 17 different types could be fitted in the compact camera nose of the Reporter, which added 9 in (23 cm) to its length over that of the XP-61E on which it was based.

F-15A to RF-61C
In June 1948, the USAF redesignated all its aircraft types. The F-15A (first model of the 15th photographic reconnaissance type) became the RF-61C (a reconnaissance type based on the F-61C airframe). The F-15 was assigned the 'buzz-code' 'FH', although it is not known to have ever been worn.

Lieutenants John Biddle and Bob Brown prepare to saddle up for another mission from Clark AB. The 8th used two emblems, neither of which was authorised by the Air Force. Some F-15s had the 8-Ball painted on the tails and others had the Eagle. Note the retractable boarding step at the rear of the nacelle.

8th Photo Recon pilot Lt George Kroman is suited up and ready for a flight in his Northrop F-15A Reporter from the 8th's HQ at Johnson AB, Japan. The 8th was attached to the 35th Fighter Group at the time.

F-15A incident over Korea

Lieutenant George Kroman remembers a close call in the F-15A, over South Korea while on a photo-mapping mission over the east coast of South Korea just south of the 38th Parallel. His co-pilot was Second Lieutenant Rolla M. Bishop, the date was 18 November 1948.

"We were flying at 20,000 ft when we arrived in our assigned area. I think that the temperature outside the cockpit at this altitude was about -50°F. We were wearing sheepskin flying suits as the RF-61Cs had no electric heated suit capabilities. All I remember is that we were both very cold. When we completed our photo runs, Lieutenant Bishop asked if we could get out of there quick because he was freezing.

"I remember cutting back on the power, pushing the nose down a little and starting a right hand, descending, turning roll-over. About three-quarters of the way through the roll-over, I felt the aircraft kind of shudder and it flipped completely over on its back. I could see the airspeed falling off fast and had the feeling we were upside down. The controls were completely limp. I could move them in all directions, with no results! It scared the hell out of me. The altimeter was steadily unwinding – 19, 18, 17,000 ft – and I could see that the nose was slowly coming down until we were heading straight down with the airspeed building up like mad. In a matter of seconds it went past the red line. I don't know what speed we got up to, but it was well over 500 mph.

"I remember the guys in the 35th Fighter Group, back at Johnson AB, called the RF-61Cs 'the whistling shit houses' because of the whistling noise that the turbo-superchargers made. Well, while we were in this dive, they were screaming like a Stuka dive-bomber. While trying to pull on the elevator controls, it seemed like they were anchored in concrete. As the ground was rushing up, in desperation I reached forward and gave the elevator trim tab a couple of quick pulls and it took effect immediately. We started one hell of a fast pull-out! I don't know how many *g* we were pulling. I remember the terrific weight and everything went blank. The next thing I remember was looking around half-dizzy and sickish and the aircraft was going straight up and about to stall. I had enough sense of self-preservation to push the throttles full forward to get the power back on the engines. I got the nose down and everything back to normal.

"The flight back to Itazuke AB, Japan was uneventful. My backseater came on the intercom and wanted to know what happened, as he had blacked out also. It was a flight I will never forget. I had the ground crews give the aircraft a complete check-up and they could find no after-effects of the high-*g* pull-out. It was one tough old bird!"

Enlisted personnel of the 8th Photo Recon Squadron line up for a group picture, in front of an F-15A at Johnson Air Base, Japan. This was taken in early 1948 when the squadron was deeply involved in photo mapping of a vast area in the Pacific.

were eventually flown from Vero to MCAS Cherry Point, North Carolina, then ferried to the West Coast and the 'boneyard'. The FT-2s, although not considered active inventory, were dormant until the last were phased out of inventory during the summer of 1947. Their tenure with the Marines had been cut short not by jets, but by another twin-engined prop fighter.

With the successful testing of the new jet prototypes (P-59 and P-80), a distinct problem cropped up: how does the pilot of a jet-propelled fighter escape from his aircraft

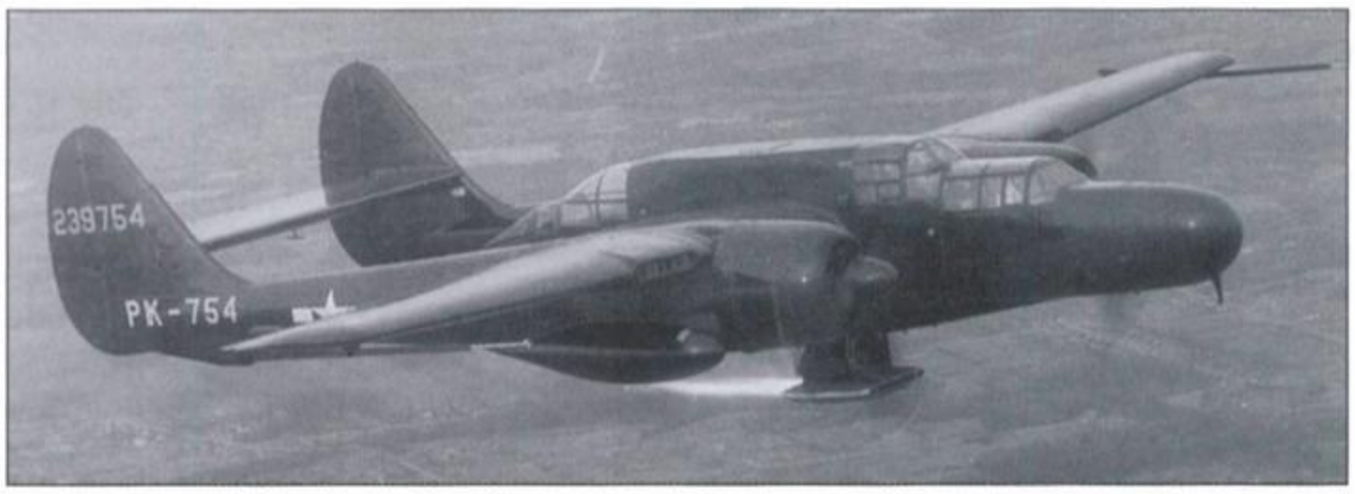
FT-2 Marine Widow

After expressing interest in the P-61 for some time, and several false starts due to Army requirements, the Navy was allocated 75 P-61s in early 1944. There were to be follow-up batches of 90 and 150 aircraft, and training of Marine Corps technical crew had begun at Hawthorne by the time the Navy cancelled its order in July of that year. At the time, it was expected that the F7F Tigercat would enter service before the war ended, and performance estimates favoured the big Grumman. Ironically, the few Widows that saw service with the Marines were used as radar trainers for the F7F-3N Tigercat. Twelve P-61Bs, BuNos 52750-52761, were delivered to the Marines' night-fighter school at Vero Beach, Florida in September 1945. They were used to train radar operators, an instructor riding in the rear compartment with the trainee. By April 1946, the training programme was wound down and the aircraft disposed of. Two were written off, one on its flight to the storage yard when the pilot retracted the gear too soon.

A group of curious Marines takes a look at a newly arrived FT-2 (P-61B) at the Marine Training Facility at Vero Beach, Florida. This aircraft retains the turret, which was soon removed to save weight and drag, and also because the Tigercat, for which the FT-2 was used to train crews, relied on fixed cannon alone.

This is the only known named FT-2, with **Cal-Donia** *inscribed behind the nose code number. The boom carries the 'VF' code, signifying Vero Beach NAS.*

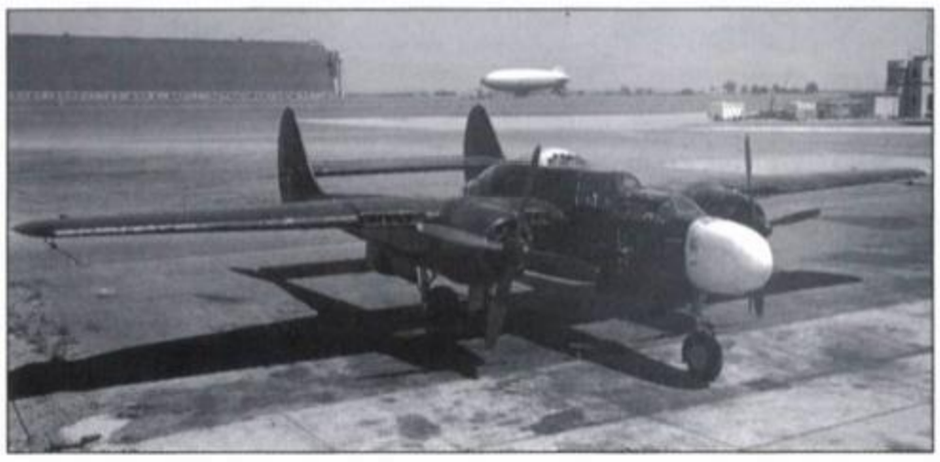
Above and below: NACA Lewis used this P-61B (42-39754) as a subsonic ramjet testbed between October 1945 and October 1948. It is seen below with a unit, described as a "wing-type rectangular ramjet", in action. Buzz numbers on black aircraft were usually, but not always, red.



NACA's aircraft

Two Black Widows and a Reporter were acquired by NACA Ames for the launching of instrumented aerodynamic transonic or supersonic test models from high altitudes (42,000 ft/12800 m). After launch they were recovered by means of airbrakes and parachutes. Among the NACA pilots who flew these drop tests were George Cooper, Rudolph Van Dyke, Robert Whempner and Joseph Walker (later of X-15 fame). The aircraft used included an RF-61C (F-15A), and an F-61C borrowed from the Smithsonian collection. Both these aircraft (a third was used as a spares source) survived NACA's experiments, the F-61 returning to storage and the F-15 joining the civil register as a survey aircraft. NACA's Lewis facility used a single P/F-61B to test Marquardt ramjets.

Below: NACA Ames ERF-61C NACA 330, later redesignated NACA 111 (42-8330), was bailed from the Smithsonian Institution for air drop tests and was used from 5 February 1951 to 10 August 1954 to air drop aerodynamic shapes. When the tests were over, the Black Widow returned to the Smithsonian for storage, where it remains today.



Left: Seen with the giant airship hangars of Moffett Field and a USN 'Z-Ship' in the background, NACA Ames P-61A 42-5572 was acquired for flight test duties between 20 April 1944 and 16 November 1944. Among its duties was towing a waxed, propellerless P-51B to altitude and releasing the instrumented and manned aircraft at height in a programme to verify wind tunnel data. Turret buffet was studied in a separate NACA study.

safely? The days of a pilot gently pulling his aircraft into a nose-up attitude and stepping off the wing were history. The Germans were the first to delve into the mechanics of an ejection seat, when they designed pusher-prop aircraft such as the Do 335. The pilot would have been killed by the rear propeller had he bailed out.

Solving this problem was a high priority for the Air Corps in late 1945. The first attempts to perfect an ejection seat were conducted in the P-80 during the month of August 1945. The method of propelling the seat clear of the stricken aircraft was unsatisfactory, so the project was taken back to the drawing board. A P-61B was selected to perform the next series of tests, in which the ejection seat would be set up in the forward gunner's compartment, right behind the pilot. The Black Widow rigged for the tests was appropriately named *Jack-in-the-Box*.

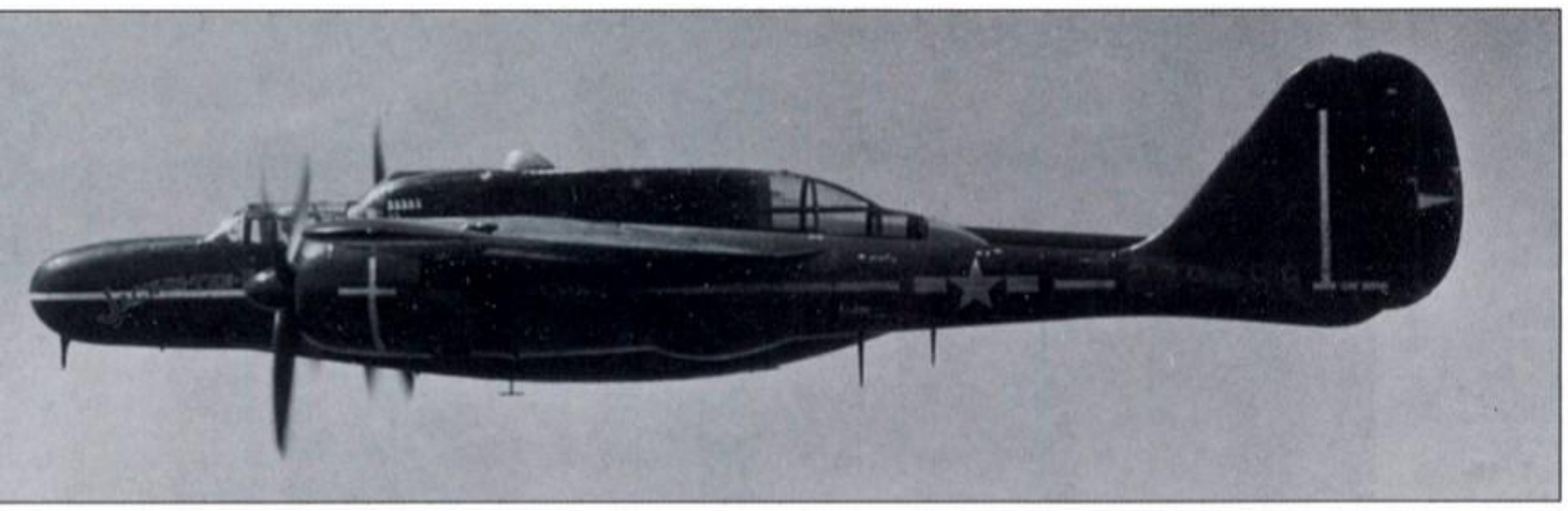
It had been determined that the best and safest way to get the pilot and seat clear of the aircraft was to use a 37-mm cannon shell. Initially, a 300-lb (136-kg) dummy was used to test the seat's reliability at various speeds. The P-61 test ship was flown at speeds from 150-300 mph (240-480 km/h), with the pilot having total control over the ejection system. All went well, and the scene was set for a human to occupy the seat. On 17 August 1946, First Sergeant Lawrence Lambert became the first American to be ejected from an aircraft. Lambert's comments, following the completion of the test, indicated that there was nothing traumatic about it, and that there was no jolt when the parachute opened, unlike when jumping from an aircraft and using the static line to activate the parachute. The speed of the Black Widow at the time of Lambert's ejection was approximately 302 mph (486 km/h) and the altitude was 7,800 ft (2377 m). The tests continued for several months, with a second subject, Corporal Harry Brickheimer, logging multiple ejections.

Not all problems for future ejection seats were solved with these tests, which merely laid the groundwork of basic knowledge. Within a few years, jets were exceeding the speed of sound at an ever-increasing Mach number, bringing about an entire new set of problems. Propeller aircraft could no longer be used for tests, as their speed was not high enough.

The Saga of NX30020

No other P-61 made more effort to achieve success and to survive in the post-war era than this aircraft. If there had been a future for the Black Widow, 42-39419 would have found it. At the end of the war, it was bailed to Northrop

The great post-war hope for Northrop was the B-35 flying wing. After a long series of technical and political problems, the company abandoned flying wings (at least until the 1980s). Northrop had more success continuing with developments of the all-weather fighter concept, leading to the F-89 Scorpion. Little is known of the P-61's use, if any, in the B-35 programme. The Widow seen here is the second P-61C.

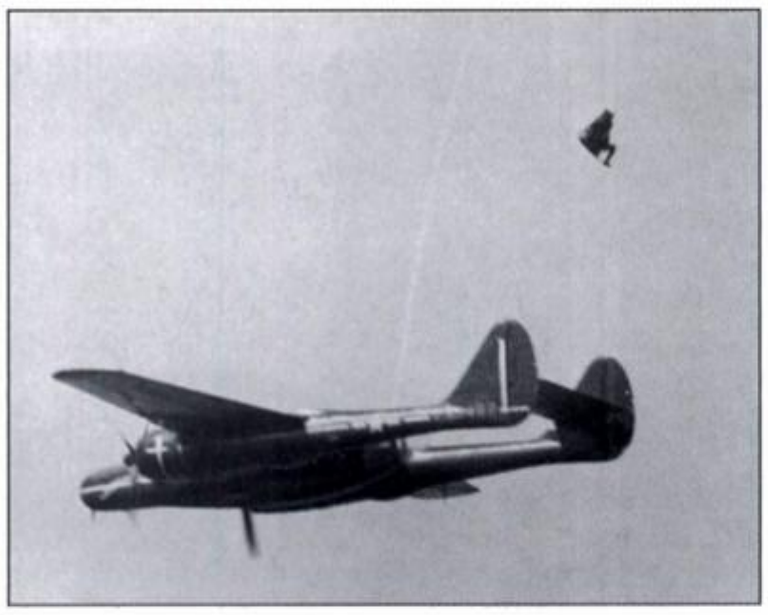


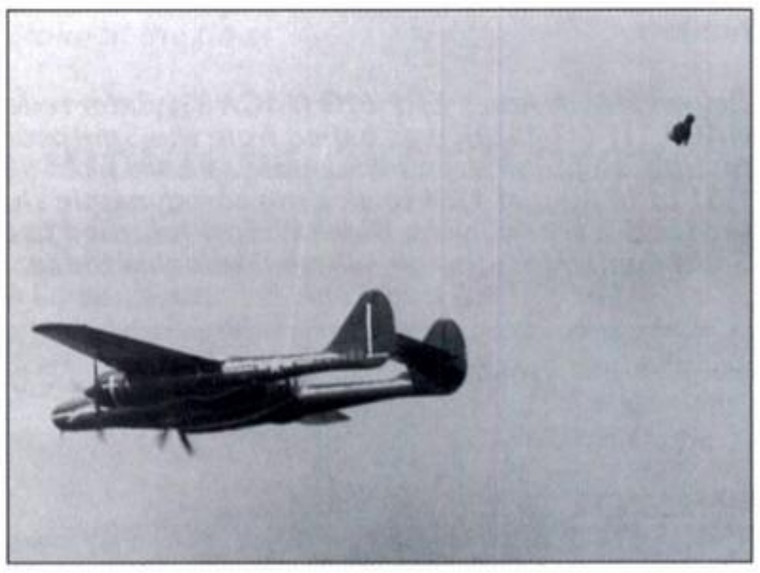
Jack-in-the-Box

The P-61 played an important role in the development of US ejection seats, becoming the platform for the first live ejection test in 1946. The seat fitted to P-61B 42-39488 was the T-2, manufactured by the Frankfort Arsenal. Many early seats were fired by compressed air catapult and rockets; some, including the T-2, were propelled by explosives, in this case a 37-mm cannon shell. The first live test was carried out at Patterson AFB on 14 August 1946 with Sergeant Lawrence Lambert as the test subject. Most of the subsequent test firings were performed by Corporal Harry Brickheimer.

The P-61B modified for the ejection seat tests is seen just before the seat was activated. The name* Jack-in-the-Box *was written on the port side of the crew nacelle.

Corporal Harry Brickheimer is interviewed by the press after a successful ejection from the gunner's compartment of the P-61B. No special gear was rigged for the tests, as can be seen here, right after Brickheimer's landing.



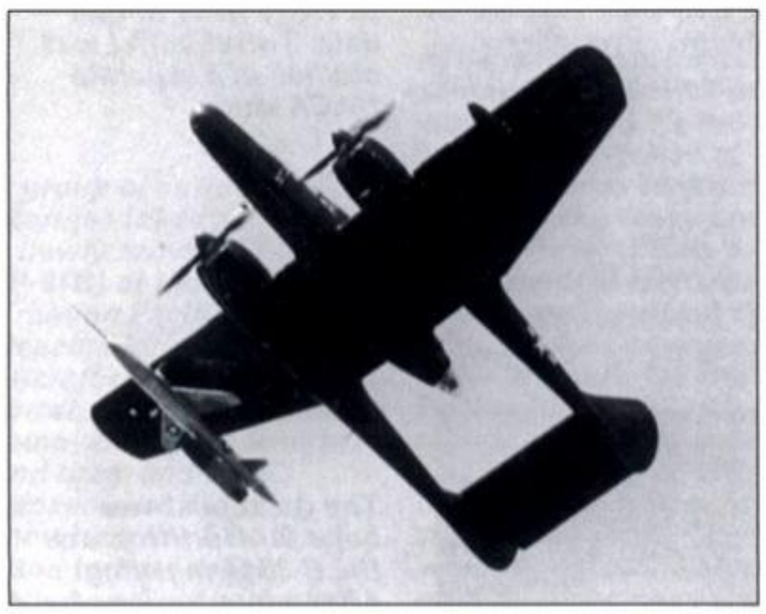


The power of a 37-mm shell is graphically demonstrated as Cpl Brickheimer is flung clear of* Jack-in-the-Box *during a press demonstration.

from the military, and for some time was flown by Northrop Vice President, John Myers. He had made arrangements to purchase it from Northrop and its civilian registry number became NX30020. During the years after the war, it was used in many roles such as executive transport and flight-test chase plane. This aircraft stayed busy, when most P-61s were being delivered to the 'boneyard' and sure extinction.

In the early 1950s, NX30020 was purchased by a photo-mapping company in Texas. Before the new owner could convert the aircraft to meet its needs, the company ran into financial problems. The airframe was parked and derelict for some time. Finally, in a state of disrepair, it was purchased by Aircraft Sales Ltd of California, which intended to convert it to an executive transport that would comfortably carry seven passengers. There were no takers.

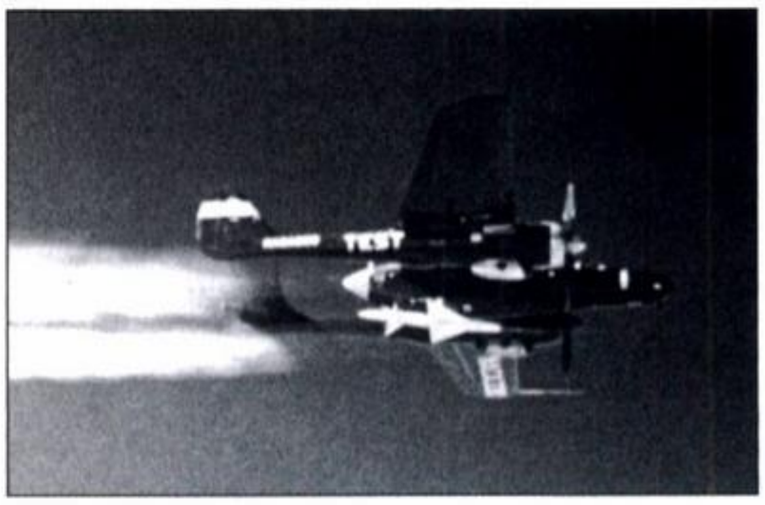
Through sheer luck, the ageing Black Widow was then purchased by an air tanker company in California, for conversion to an aerial fire-fighter. At the time, this industry was dominated by converted warbirds, which performed outstandingly in their new roles. Our P-61B went through the conversion ritual and received a huge 1,600-US (6056-



NACA 111 is shown above with an aerodynamic figure slung below its left wing, and the agency's F-15A is seen below with a similar swept-wing body ready for release.

Above and left: The P-61 was one of the few aircraft suitable for underwing carriage of large test missiles such as the Martin Gorgon IV ASM, powered by a Marquardt ramjet. The P-61C-1 used for trials in 1947 proved capable of carrying two missiles in dives of up to Mach 0.5.

Below: Carrying an aerodynamic shape on the centreline, NACA Ames's ERF-61C NACA 330 prepares for another high-altitude test drop in the early 1950s.



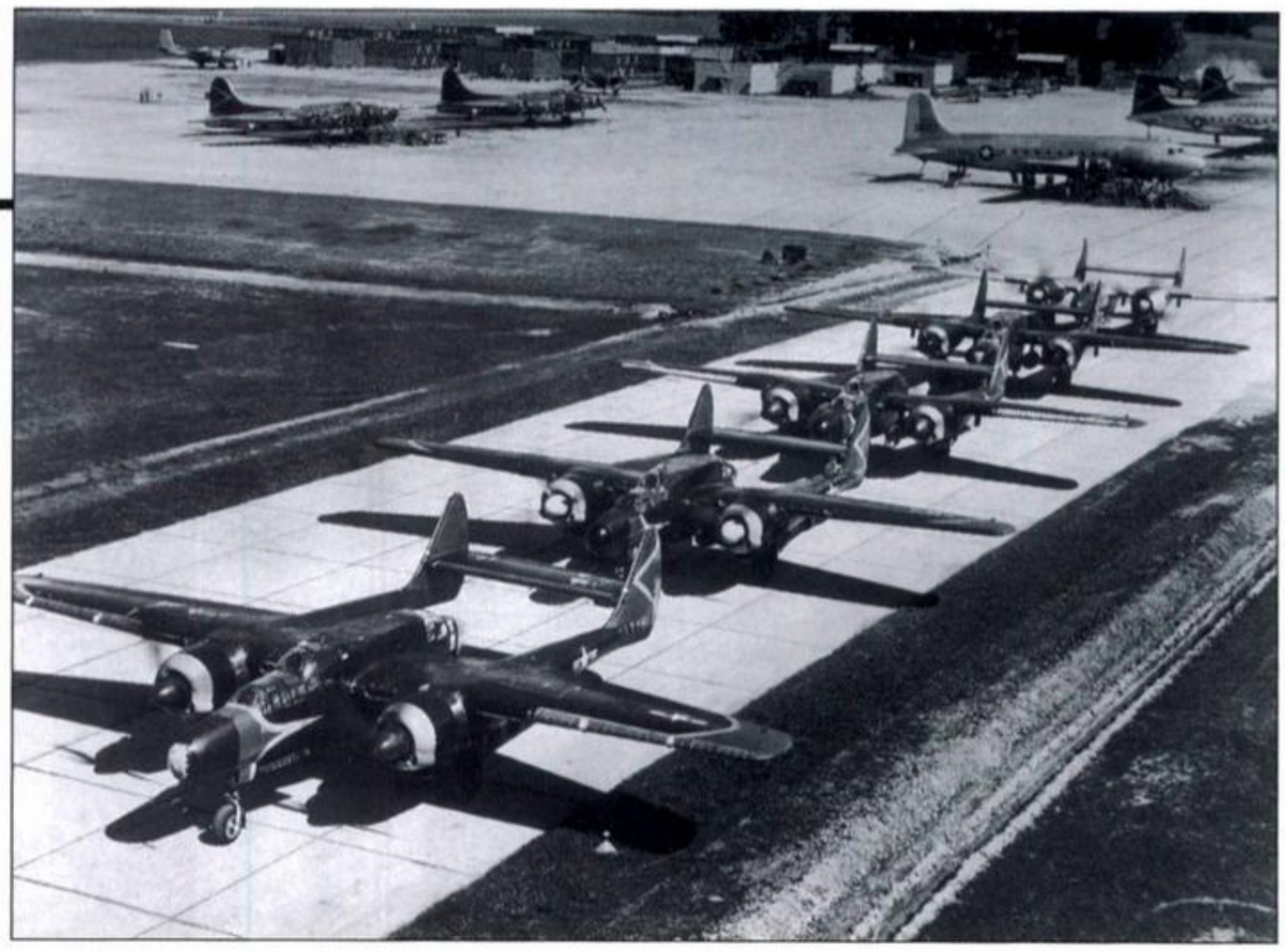
Left: At war's end, NACA set out to conduct various tests on recoverable aerodynamic bodies that could be dropped at altitude, free fall, record vital data and be recovered to use again. 45-59300 was the first production model of the F-15A-1, and was used as NACA 111 at Moffett during 1948-54.

Operation Thunderstorm

After World War II, the US government and the FAA were trying to establish guidelines to cope with the expected boom in civil aviation, with safety being paramount. However, one factor the regulators and aviators had very little control over was the weather. Even up to the early 1990s, such phenomena as windshear remained a mystery and much effort was expended in experiments aimed at the development of early warning systems for pilots. In 1945, the US Congress gave $250,000 to the US Weather Bureau to study violent weather, particularly furious thunderstorms that arise suddenly, especially in Florida. The main operational base for the thunderstorm study was Pinecastle Field, Fla., from where test flights were conducted between 29 June and 18 September 1946. It took until the summer of 1946 to get everything in place, including setting up several microwave early warning stations. Not only could they detect and track a sudden storm, they could also track the project's aircraft as they penetrated the front. Phase I took place near Orlando and involved nine specially-fitted P-61Cs rigged with weather instrumentation and recording devices. All were flown by experienced pilots from the USAAF. As soon as a storm was detected, five P-61s were put into it at 5,000-ft (1524-m) intervals, from 5,000 ft to approximately 25,000 ft (7620 m).

Phase II of Operation Thunderstorm – carried out at the Clinton County Army Air Field in Ohio – was to explore the heavy storms that accompany a weather front when it moves into an area. The equipment reached the test base on 10 February 1947. This time there were 13 P-61Cs, plus four variants sent by Northrop: two production F-15As, the XF-15 and the XF-15A. Another aircraft was added right before the first flights started, a lone P-61B-25 bailed to Trans World Airlines (TWA) for weather testing and brought to Clinton County Field. It was flown by TWA pilot Robert N. Buck. The first official flights of this phase began on 1 May 1947. All aircraft got plenty of flying time and took numerous lightning strikes; their Plexiglas noses were damaged by hail hits and several had to be replaced.

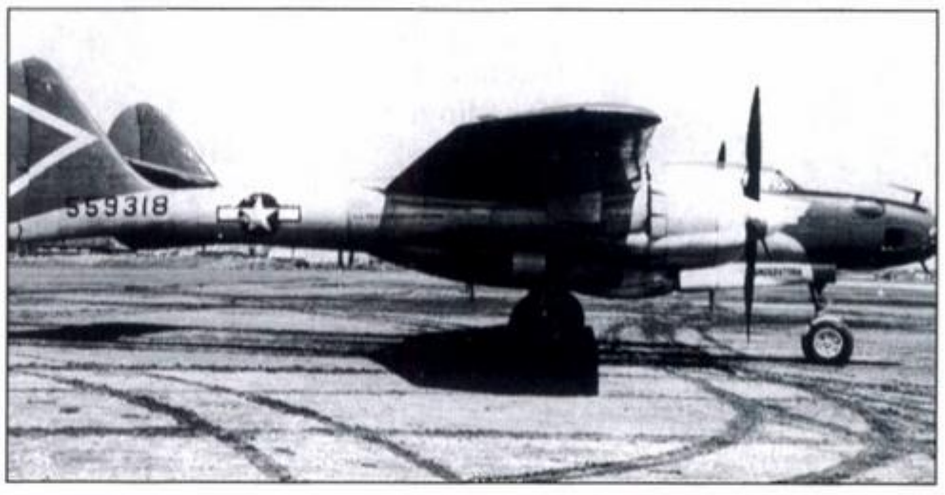
The data gathering was suspended in late 1947 and the University of Chicago was responsible for assimilating everything that had been recorded, both in Florida and Ohio. These results were to contribute greatly to the knowledge of extreme weather and the safety of civil aviation.



Five P-61Cs and an F-15 move out for a thunderstorm penetration in 1947 from the All-Weather Flying Center in Ohio. The aircraft would penetrate the storm at different intervals, recording temperatures and pressures and photographing cloud patterns. The nosecone of the lead Widow shows the battering caused by rain, hail and lightning.

litre) chemical tank custom-fitted to the underside of the crew nacelle. In April 1963, the airframe was certified as airworthy to perform its new job. Approximately 19 years after it was manufactured, the old Widow was breathing again.

On 23 August 1963, the tragic end came for this aircraft. A forest fire raged on the Tule River Indian Reservation in California and a large number of warbird types had been thrown into battle against it, the P-61 being one of them. It was flown by Robert E. Savaria, a former P-61 pilot during the war. Savaria had already made four drops into the fire and was returning for his fifth run. Coming in very low, his wing clipped some trees about 15 ft (4.5 m) above the ground: NX30020 cartwheeled and burst into flames. Savaria was killed and the aircraft was totally destroyed.



Above: This very rare colour image shows the red and yellow trim of the All-Weather Flying Center on a Project Thunderstorm P-61.

The F-15A-1 attached to Project Thunderstorm also wore the colourful yellow and red markings of the All-Weather Flying Center.

Gorgon missile tests

The US Navy was heavily involved in testing the Gorgon IV missile's engine during 1947/48. The Gorgon began as an air-to-air weapon, but also evolved into a ramjet-powered air-to-surface weapon. The powerplant was built by the Marquardt Aircraft Company and the airframe was designed and built by the Glenn L. Martin Co. Gorgon IV propulsion test vehicles, designated PTV-N-2s, were taken to altitudes above 25,000 ft (7620 m) and released by P-61s. Over 75 of these launches were conducted, using two P-61Cs (43-8347 and 43-8336) bailed to the Navy. Two of these 2,400-lb (1089-kg) missiles could be carried by one aircraft. Another variant was the KDM-1 target drone, developed into the Plover chemical attack glide weapon, which had an Edo aerosol generator in place of the ramjet. Dropped at 35,000 ft (10670 m) and about Mach 0.95, the Plover's profile was to dive at 16° for 20 nm (37 km), flying for another 5-11 nm (9-20 km) at 100-500 ft (30-152 m). The spray run could cover a strip at least 5 nm (9 km). None of these experiments ultimately led to a service weapon.

The Widow will fly again

On 10 January 1945, Lieutenant Logan Southfield, in one of the 550th NFS's new P-61s, attempted to make a near vertical climb of 7,000 ft (2133 m) from tree-top level to the top of Mount Cyclops, New Guinea. On his two previous attempts, he had run out of airspeed and been forced to abort the climb; on this try, he ran out of airspeed and ended up in the thick jungle canopy, at 4,500 ft (1371 m). All four on board, including two unauthorised passengers, survived with minor wounds, although Southfield was seriously injured in falls while running down

45-59300, the last of the F-15s, had its final incarnation as a fire-bomber. It was with Cal-Nat Airways Ltd of Fresno in October 1967 when seen here. Less than a year later it had been destroyed. In civilian use, it had a T-33 canopy and, at different times, P-61, F4U-4 and L1049 propeller blades.

Civil Sixty-Ones

A very small number of Widows and only one Reporter were ever placed on the civil register. The first production F-15A served with NACA, then in civilian hands as a photo-survey platform and as a fire-bomber until its loss in a 1968 accident. The last airworthy P-61 met a similar fate in 1963. As well as those shown here, a few others were civilianised, but saw little or no use before being scrapped. Another, a YP-61, was used by the Civil Aeronautics Authority until written off in a 1956 ground mishap.

N30020 (P-61B-1 42-39419) is seen, above, when used as a photo-mapping aircraft and, at left, after conversion to fire-bomber configuration. The aircraft had been bailed to Northrop for most of its career, and was purchased by them after the war. Other uses for this Widow included executive transport, chase, and navigation equipment test. It was lost in a fatal crash while fire-fighting in August 1963.

The only non-US registered Black Widow or Reporter was XB-FUJ, later to return to the US as N9768Z. From 1956 to 1964 it was used for aerial survey by Cia Mexicana S.A.

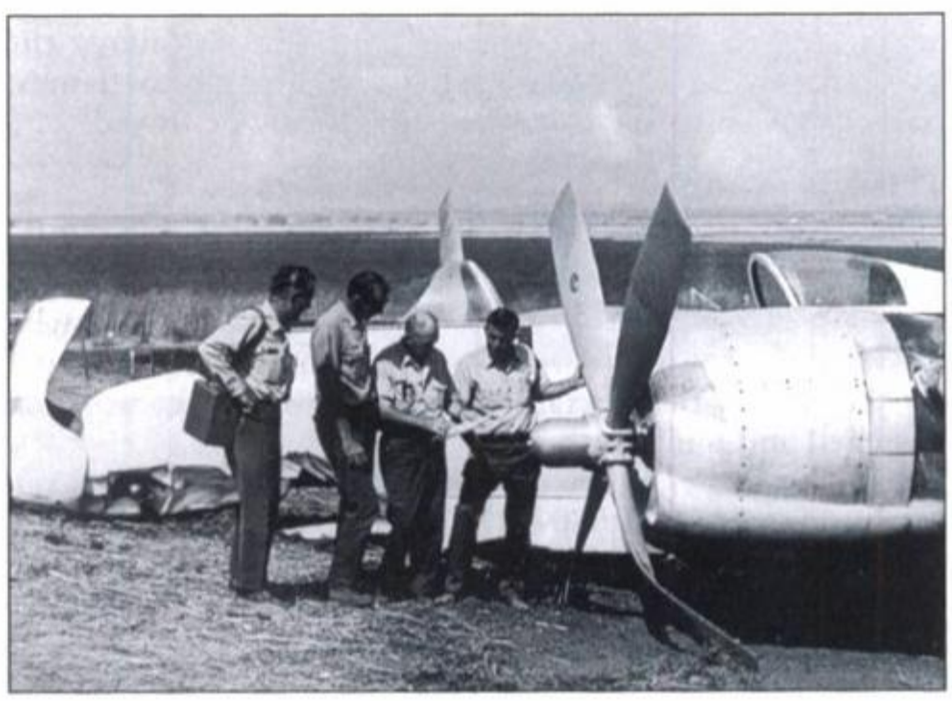
Below: Photographed moments after coming to rest in a field at the end of the runway at Hollister, Calif., N9768Z begins to burn. The quick intervention of TBM pilot Carl Kennedy, who bombed the wreck with retardant, saved pilot Ralph Ponte.

the mountain to get help. The aircraft was left where it lay, basically intact. For 40 years, this relic was known only to missionaries and native tribes.

Word of this P-61 reached Gene Strine of the Mid-Atlantic Air Museum in Reading, Pennsylvania. Forty years after the crash, he made the journey to New Guinea and up Mount Cyclops. During the early 1980s, most of Strine's trips to New Guinea had been to raise the necessary money to dismantle this rare P-61B and bring it down the mountain via helicopter. Finally, in 1991, everything was in place, a clearing was cut in the jungle and a civilian Super Puma helicopter lifted the big warbird from the slope. The parts were put into 15 crates, weighing 26,000 lb (11790 kg), and shipped to the United States. Over the past three years, the restoration process has been underway at Reading, and thanks to donations from the well-organised World War II Night-Fighter Association, the work is on-track. Hopefully, the P-61 will be able to fly again on the 60th anniversary of its crash on the side of Mount Cyclops.

Of the four P-61s known to exist today, only two were ever in a hostile environment. Very little is known about the Black Widow in China, but it is a B model probably flown by the night-fighter units operating in China during the war (the 426th and 427th NFSs). Although it has been said the Chinese will let anyone have it for about $2 million, the wing spar is thought to be so corroded that the aircraft would collapse if moved, and there have been no takers to date. Rumours persist of more P-61s in China. Only one P-61 – a C that saw no combat – has been restored to viewing condition, and it is owned by the Air Force Museum in Dayton. It is painted in 550th NFS colours and named *Moonlight Serenade*, an aircraft which actually existed but was not a C. Another C is owned by the Smithsonian's Air & Space Museum. It is still at the Paul F. Garber restoration and storage facility, waiting to be brought up to static display condition.

Warren E. Thompson



Crash inspectors study the remains of the last flyable member of the P-61/F-15 family. Today, an aircraft damaged like this would be considered rebuildable, but in 1968 it was thought fit only for the scrapman.

The last Widows

Only four Black Widows are known to survive today. Two are preserved for the major US national collections, one is on display in China and another is under restoration to fly in Pennsylvania. Along with the A-20 Havoc, it is the only major American combat aircraft of the war not to be represented by a flying example. The aircraft on display in China was one of a detachment of three P-61As of the 427th NFS that were taken by Chinese Communist troops at the end of the war. The possibility exists that there are other survivors in China. The aircraft under restoration in Pennsylvania crashed in western New Guinea in 1945 and, after many struggles, was returned to the USA in 1991. It is the best hope for seeing a Widow fly again – some time early in next century.

The USAF Museum's example is a P-61C which had been donated to the Boy Scouts of Urbania, Ohio in 1954. Sold to collector Earl Reinert of Illinois in 1958, who never collected it, it was passed to the USAFM in that year. Seen on outdoor display, it has since been fully restored in the markings of 550th NFS P-61B Moonlight Serenade.

Above: After return from bailment to NACA, the Smithsonian's P-61C, 43-8330, was placed in outdoor storage at Andrews Air Force Base, Maryland. Today, it remains in much the same condition indoors at NASM's Garber facility.

Below: The wreck of 550th NFS P-61B-1 42-39445 on the slope of Mt Cyclops near Hollandia in Irian Jaya is seen at the time of its 1988 recovery. The Widow crashed at 7,000 ft (2133 m) in January 1945 when the pilot tried to out-climb the slope. A large clearing had to be cut in the forest to allow a helicopter to lift the airframe out and carry it down to Hollandia airfield, visible at top right.

Above: The P-61B on display at the Beijing Aeronautical Institute has been marked as '7602' and '25171', but its exact identity remains unclear and it is not known what use the Chinese air force might have made of it and the other captured examples. Western warbird collectors have reportedly offered six-figure sums for the Widow. The Institute's La-9 has since been sold to a UK operator.

Above right, below, and below right: Three views show the restoration work in progress on P-61B 42-39445 at the Mid-Atlantic Air Museum (MAAM) in Reading, Pennsylvania in late 1998. The restoration team hopes to have the aircraft, less wings, standing on its gear by the end of 1999, but is reluctant to estimate a first flight date (as N550NF). Northrop test pilot John Myers has contributed substantially to the restoration fund.

P-61 Operators

US Army Air Forces (wartime)

6th NFS

The lineage of this squadron dates to March 1917 and its roots had always been in the Pacific, where most of its operations staged from various bases in Hawaii. It was redesignated as a night-fighter squadron on 18 January 1943. From the early P-70 days, it had detachments in New Guinea and on Guadalcanal. The squadron was in Hawaii when it received its first Black Widows in May 1944, and was the first to receive the new aircraft in the Pacific theatre. The initial aircraft for the squadron had the olive drab finish but, by the time the full complement had been received, most had the gloss black finish. From that point, the 6th took the war into the heart of the Japanese Sphere of Influence, flying from bases on Saipan and Iwo Jima. The 6th became the third-highest-scoring P-61 squadron (in all theatres), with 16 confirmed kills, scoring its first kill on the night of 20 June 1944.

Widows of the 6th NFS fly over Kagman Point, Saipan. The 6th was the first P-61 unit to fly combat in the Pacific Theatre.

414th NFS

The 414th's activation date was 26 January 1943, with no prior history. It flew several aircraft types in the Mediterranean theatre of operations (MTO), but became renowned for its exploits with the British Beaufighter in the night-fighter role. The squadron received its first P-61 on 20 December 1944, and had the good fortune to send a detachment to Belgium to operate with the 422nd NFS during the Battle of the Bulge. This gave the aircrews plenty of experience with the new Black Widows. The 414th ended the war with five confirmed kills in the P-61, its first kill coming on the night of 4 February 1945. While operating the new Northrop fighter, the 414th's primary base was Pontedera, Italy, but in the spring of 1945 it operated from Strossfeld, Germany. The squadron was inactivated on 31 August 1947.

First Nighter ***was flown by the 414th NFS at Pontedera, Italy in late 1944 and 1945. This P-61 was one of two that were purchased and named by Northrop employees.***

415th NFS

Like its sister squadron, the 414th, the 415th was one of four night-fighter squadrons that undertook its combat tour in the MTO. It was activated on 10 February 1943 and its combat time included stations in Tunisia, Algeria, Sicily and Italy. Its primary aircraft type during the heated battles in 1944 was the Beaufighter, and the 415th did not receive its first P-61 until 20 March 1945. By this time, there was very little enemy air activity at night and no kills were made while flying the Black Widow. As the war wound down, the squadron operated from bases in both France and Germany. The 415th was officially inactivated on 1 September 1947. It became the 449th All Weather Squadron, based in Alaska.

Lt Alvin G. Moore, a pilot with the 415th NFS, poses with P-61-B-15 (42-39606) **Li'L Abner** ***in France.***

416th NFS

Activated on 20 February 1943, the 416th was not considered to be a true P-61 squadron during the war, as it did not receive its first Black Widow until 3 June 1945. It was unique among MTO night-fighter operators in flying both the Beaufighter and Mosquito in combat, getting six kills and one kill, respectively. The squadron was inactivated on 9 November 1946, and became the 2nd Fighter Squadron (All-Weather). These squadrons are covered in later entries.

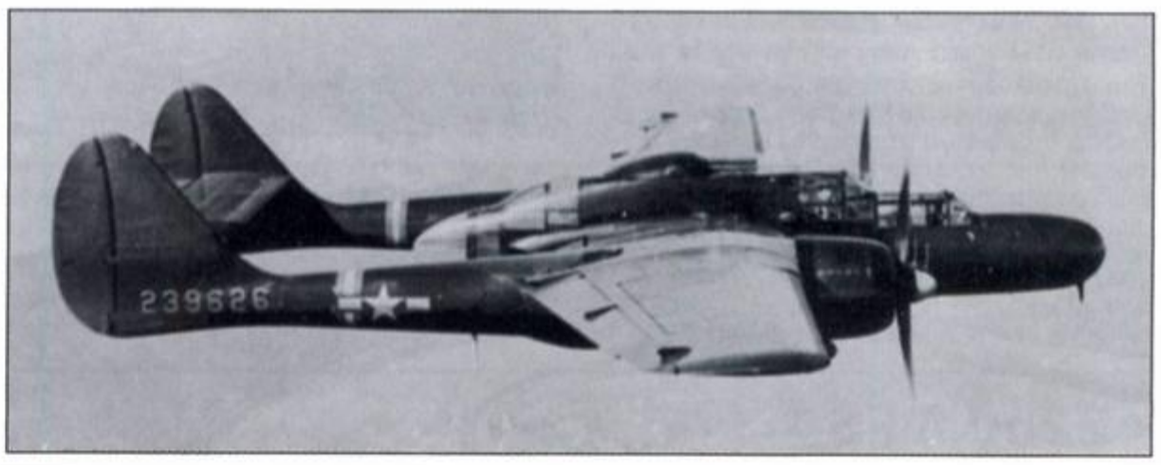
A 416th NFS Black Widow warms up for a daylight training mission over Germany and Austria. This photo was taken at a former major Luftwaffe base at Horsching, Austria in autumn 1945. Note the coloured tail band and spinners.

Above:* Markey, *a P-61B-6-NO, rests on its hardstand at a base in eastern France during the early summer of 1945. It was assigned to the 417th NFS. This photo was probably taken at St Dizier just prior to the squadron's move to Giebelstadt, Germany.

417th NFS

Activated on 20 February 1943, the 417th was the fourth night-fighter squadron to see combat in the MTO. It, also, was not considered to be a P-61 squadron during the war. It distinguished itself flying the Beaufighter from bases in Algeria, Corsica, France and into Germany at war's end. During April/May 1945 it received a few P-61Bs while operating from Giebelstadt, Germany, when German nocturnal activity was almost non-existent. The 417th was inactivated on 9 November 1946 and was renamed the 5th Fighter Squadron (All-Weather).

Right: Taken after war's end when the 417th NFS was receiving its full complement of new Black Widows, this shot shows the distinctive tail bands of this unit. This aircraft (42-39626) was a rare P-61B-16-NO of which only six were built, most serving in the Mediterranean Theatre.



418th NFS

This squadron distinguished itself in the Pacific theatre of operations (PTO), while flying the P-61. It was activated on 1 April 1943, and upon completion of night-fighter training began its journey through hostile skies while operating from New Guinea. Prior to receiving Black Widows in September 1944, it flew the P-70, P-38 and B-25. The squadron went on to shoot down 18 Japanese aircraft, becoming the second-highest-scoring P-61 squadron in World War II (in all theatres), and scored its first P-61 kill on the night of 7 October 1944. It produced one ace, the squadron's commander, Major Carroll C. Smith. The 418th was inactivated on 20 February 1947 while stationed on Okinawa, and became the 4th All-Weather Squadron, attached to the 51st Fighter Wing.

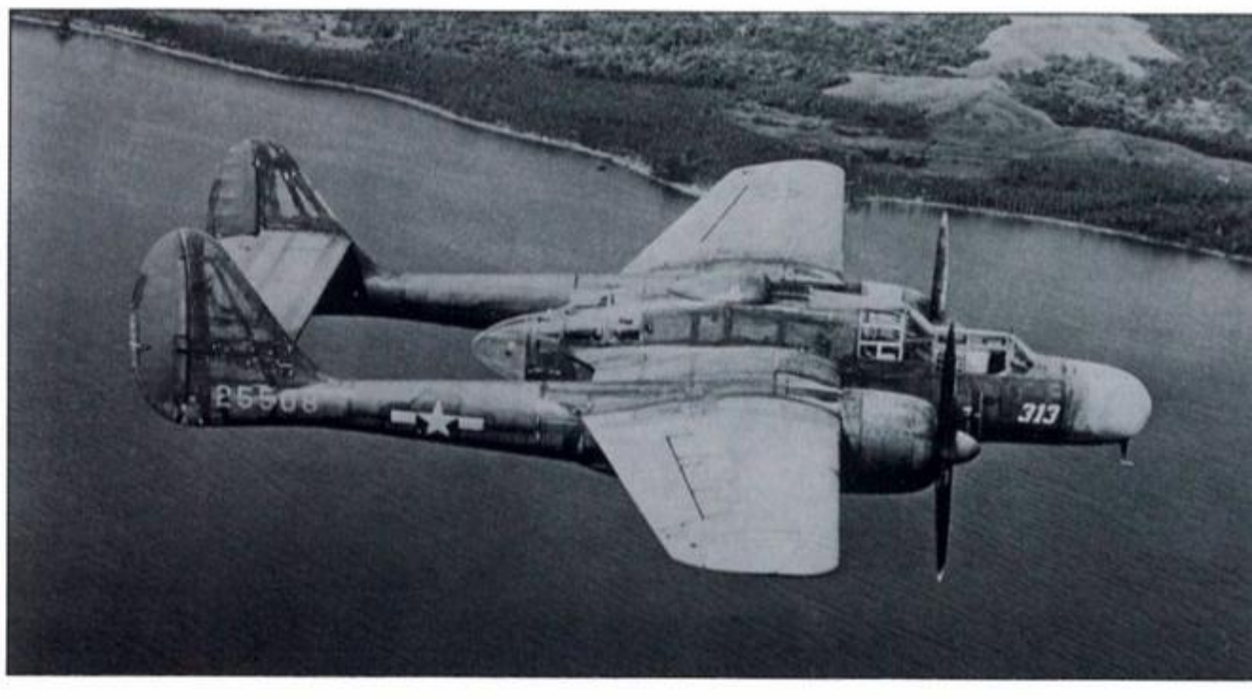
One of the 418th's Black Widows is seen on detachment to Owi Island, sometime between 16 September and 5 October 1944. A few of the squadron's Widows wore these colourful tail markings.

419th NFS

Activated on 1 April 1943, the 419th was the sister squadron of the 418th; both served in New Guinea and in the Philippines. It received its first P-61 on 3 May 1944, before the 418th, and destroyed its first Japanese aircraft with the Black Widow on 5 August. By the war's end, the squadron had racked up five kills in the Northrop fighter. Its combat experience was in the P-70 and P-38 prior to the P-61, and it probably had as much P-70 time as did either of the 6th NFS's detachments. Post-war assignments were in and around Clark Field and Floridablanca, Luzon. The squadron was inactivated on 20 February 1947.

Right: Det A of the 419th NFS on Bougainville was visited by legendary Northrop test pilot John Myers, seen on the right with company test rep M. S. Johnson. The demonstration Myers gave the squadron is still remembered today.

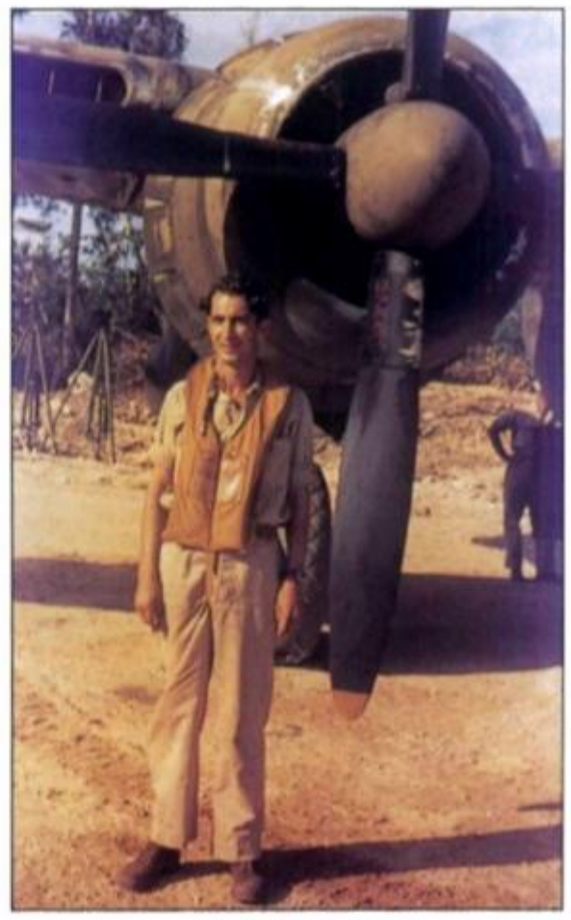
This battered P-61A-1 served with the 419th NFS. This unit's aircraft were distinguished by their italic nose numbers.



421st NFS

The 421st was activated on 1 May 1943. Under the command of 5th Air Force in the Pacific, it operated from bases in New Guinea, the Schouten Islands, and the Philippine Islands. In the early days as a night-fighter unit, it flew the P-70 and P-38, receiving its first Black Widows on 1 June 1944. On 7 July 1944, the squadron made its first kill in the new aircraft, and by the time the war ended had shot down 13 Japanese aircraft. On 8 August 1945 it moved from Clark Field in the Philippines to Ie Shima in the Ryukyus, where it remained until November, when it moved to Itazuke AB, Japan. Upon inactivation on 20 February 1947, it became the 68th All-Weather Squadron.

Above: The P-61 of Lt John Chew is seen on Ie Shima during summer 1945, after the end of hostilities.



Right: Captain William Bradley, 421st NFS commander, poses by one of his P-61As. This photo was probably taken in late summer of 1944 when the squadron was operating some of the very early production models painted in the olive drab finish.

422nd NFS

The 422nd was activated on 1 August 1943 and was under the command of 9th Air Force in the ETO. It was the first night-fighter squadron to receive its training in the P-61, the others having trained in the Douglas P-70. It received its first P-61 on 23 May 1944. Operating from bases in England, France, Belgium and Germany, the 422nd became the highest-scoring squadron in the P-61 (in all theatres), with an impressive tally of 43 enemy aircraft destroyed and five V-1s downed: the first V-1 kill was on 16 July 1944 and the first German aircraft was credited on 7 August 1944. The 422nd had only one commanding officer during the war, Lieutenant Colonel Oris B. Johnson, who retired from the USAF as a major general. The 422nd was inactivated on 30 September 1945.

***Lts Bolinder and Graham of the 422nd scored the first of their four kills in P-61A* Double Trouble.**

425th NFS

The 425th was activated on 1 December 1943. The 425th and 422nd were considered sister squadrons as both served under 9th Air Force and both launched into combat from English soil. It received a full complement of P-61s after the 422nd did. Serving from bases in England, France and Germany, it was credited with 10 kills (manned German aircraft) and four V-1s: the first V-1 kill was on 5 August 1944 and the first aircraft kill on the night of 24 December 1944. During the Battle of the Bulge, the 425th continued to operate from bases in France and did not use bases in Belgium, unlike the 422nd. Post-war, the 425th was briefly part of ADC, disbanding at McChord AFB in August 1947.

Battle "Ax", *one of the 525th NFS's P-61As, is seen on a liberated French airfield after D-Day.*

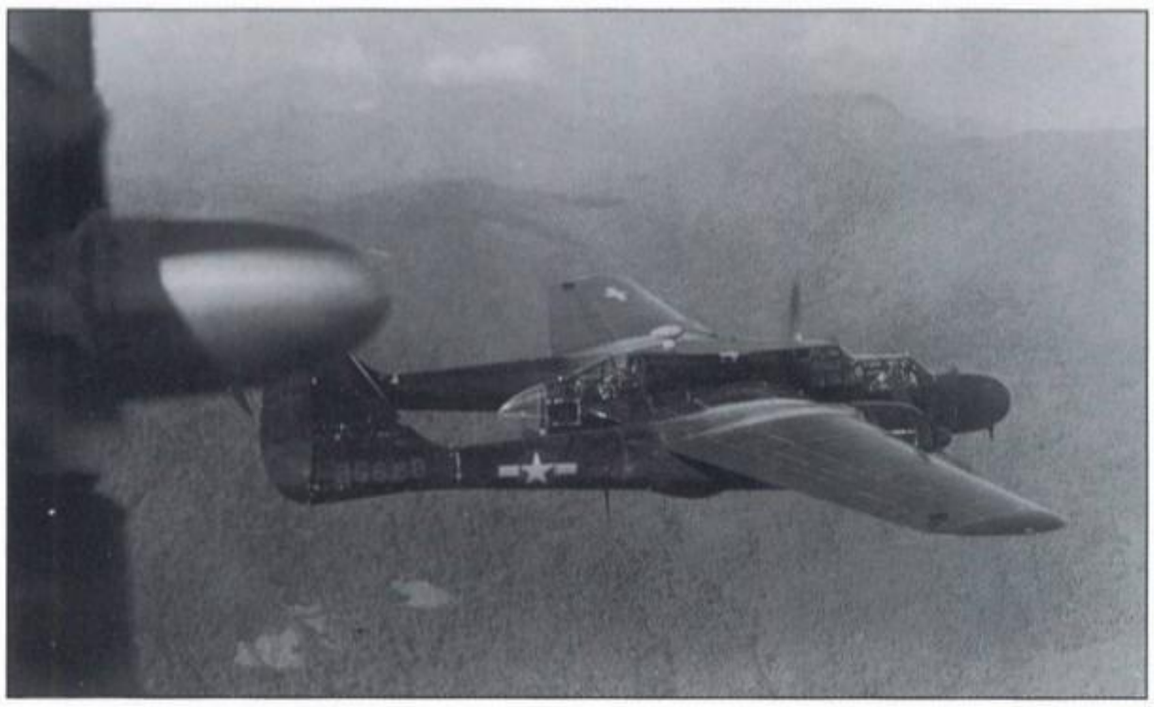
426th NFS

The squadron was activated on 1 January 1944 and flew from bases in India early in its combat tour. Most of its time was spent in China, where numerous detachments were scattered. The 426th received its first P-61 on 25 September 1944 and claimed its first aerial kill on the night of 29 October 1944. The squadron's primary mission was to protect the B-29 bases from night attack, and Japanese attempts to penetrate the P-61s' barrier patrols provided the opportunity for its five kills. It had the same commanding officer throughout hostilities, Major William C. Hellriegel. The squadron had very little post-war duty, being inactivated on 5 November 1945.

426th NFS personnel at Madhaiganj in India prepare a new P-61, just reassembled at Barrackpore, to join the squadron at the front in China.

427th NFS

The 427th NFS was activated on 1 February 1944. Upon completion of training at Hammer Field, California, it appeared that the 427th would draw the most exciting assignment to be offered to a night-fighter unit: duty on Russian soil. The deal was cancelled by Stalin and the 427th went into Italy as an MTO squadron under 12th Air Force. Lack of targets sent the squadron to the CBI, where it operated from bases in India, Burma and China. The number of targets by then had diminished significantly, and it had no confirmed kills in the P-61. The 427th received its first Black Widows in August 1944. Soon after the war ended, it was inactivated, one week before its sister squadron, the 426th (29 October 1945).



A pair of 427th NFS P-61A-10s overflies Burma in early 1945. At this stage of the war, the 427th was heavily engaged in interdiction missions with bombs and rockets.

547th NFS

The squadron was activated on 1 March 1944 and flew its P-61s from bases in New Guinea, and numerous airstrips in the Philippines such as Tacloban, Mindoro and Lingayen. Within days of the atomic bombs being dropped on Japan, the squadron moved to Ie Shima in the Ryukyus and remained there until 7 October, when it set up operations at Atsugi Air Base, Japan. It was inactivated at Atsugi on 20 February 1946. The 547th received its first P-61 on 7 October 1944 and downed six enemy aircraft during the war, the first on Christmas night 1944.

Eleven of the 547th's Black Widows are shown here on the flight line at Lingayen Gulf, Luzon, Philippine Islands in April 1945. The squadron's headquarters were at this base until after the second atomic bomb was dropped on Japan.

Little Spook, *a P-61B assigned to the 547th NFS, rests on the PSP at Lingayen in April 1945. On this and some other 547th aircraft, every other cowl flap was painted white.*

548th NFS

The famous* Lady In The Dark *is seen on Ie Shima in July 1945. It was scrapped at Clark AB in 1948. Note the squadron badge.

The squadron was activated on 10 April 1944 and operated from bases in Hawaii and on Saipan, Iwo Jima and Ie Shima. It had only one commander from activation until after the war ended, Major Robert D. Curtis. While based on Iwo Jima, a 548th pilot was called on to shoot down a crippled B-29 headed for the island after its crew had bailed out. The 548th received its first P-61s in September 1944, but did not register its first confirmed kill until 22 June 1945, and had scored five by the end of the war. One of its most colourful P-61s was *Lady In The Dark*, which drew worldwide attention after claiming to have destroyed the last Japanese aircraft of the war. The 548th was inactivated on 19 December 1945.

549th NFS

The 549th Night-Fighter Squadron was activated on1 May 1944 and was the next-to-last night-fighter unit brought into the war by the Army Air Corps. It used bases in Hawaii, Saipan and Iwo Jima, landing on the latter on 20 March 1945, less than three weeks after the 548th. For almost three months, these two squadrons operated from Iwo Jima. The 549th received its first P-61s in October 1944 and was credited with its only kill on the night of 23 June 1945. During the late spring and early summer of 1945, there was very little Japanese air activity, so the opportunities for kills were limited. The squadron was inactivated on 5 February 1946.

Pilot Lt Bill Charlesworth got all the hard-working 549th maintenance guys to line up for this group picture at Iwo Jima in the late spring of 1945.

550th NFS

The 550th Night-Fighter Squadron was activated on1 June 1944 and was the final squadron organised and trained to fly the night-fighter role in World War II for the AAC. It received its first Black Widows on 6 January 1945, the last unit to equip with the Northrop fighter. By the time it had completed training and reached the forward areas in the Pacific (December 1944), the action had shifted much closer to Japan. The 550th was based in New Guinea, Middelburg Island, Leyte, Zamboanga, Sanga Sanga and finally Palawan. The almost total absence of Japanese night intruder missions in its area translated into no kills. However, the 550th was very successful at long-range intruder work with their external fuel tanks and ordnance, and took a heavy toll on barges and road traffic around Japanese bases. The 550th was inactivated on 4 January 1946, less than one year after receiving its first P-61 and only 19 months after being organised as a squadron. The 550th only had one commanding officer for its tour of combat, Major Robert A. Tyler.

P-61A-10 42-5620 is seen here in 1945, at an unknown base 'somewhere in the Pacific'. Note the partially completed artwork on the aircraft's nose.

US Army Air Forces/USAF (post-war)

2nd FS (AW) (ex-416th NFS)

When the war ended, the 416th NFS received its P-61s while still based in Italy. It moved to Horsching, Austria in August 1945 and then to Schweinfurt, Germany on 20 August 1945. The 416th carried a major share of post-war, all-weather responsibilities in Europe until 9 November 1946, when it was inactivated. Its equipment and personnel were redesignated as the 2nd Fighter Squadron (All-Weather) at Bad Kissingen Air Base, Germany. In June 1947, it moved back to the US and settled in at Mitchell Field, New York. The parent organisation for the 2nd was the 52nd Fighter Group. The squadron became an F-82 operator in 1948.

The 5th and 2nd Fighter Squadrons (All-Weather) served together at Mitchell Field under the 52nd FG. Note the coloured band, probably white, on this 2nd FS (AW) P-61.

4th AWS (ex-418th NFS)

When the Japanese surrendered, the 418th was based on Okinawa. It moved to Atsugi, Japan in early October 1945 and participated in the occupation of Japan. Two other night-fighter squadrons also operated from the main island. On 20 February 1947, the 418th was officially inactivated and had already moved its main base to Yontan Air Base, Okinawa. On 20 August 1948, the 4th All-Weather Squadron was reactivated and given the former 418th's equipment and personnel. By this time, the squadron's P-61s were in the worst shape of any operating within the USAF. In 1948, the 4th traded its Black Widows for the newer F-82Gs. It was one of the first squadrons to be involved in the Korean War.

Seen at Mitchell Field in June 1948,* Little Texas King *was one of several 5th FS (AW) aircraft with crudely-painted names and white radomes.

5th FS(AW) (ex-417th NFS)

The 417th fought the war with both the Beaufighter and Mosquito. During the end of hostilities, it received the P-61B while based at St Dizier, France. The 417th travelled widely during the occupation period, with bases at Biblis, Braunstadt, Kassel/Rothwesten, Fritzlar and Schweinfurt, Germany. On 9 November 1946, the 417th was inactivated. Like its sister squadron, the 416th, it became a part of the 52nd Fighter Group, being redesignated the 5th Fighter Squadron (All-Weather). In June 1948, it moved to Mitchell Field, New York. Later that year it converted to the F-82 and in 1949 moved to McGuire AFB, New Jersey. The 52nd Group was responsible for the all-weather air defence of the eastern United States.

68th AWS (ex-421st NFS)

When the B-29s dropped the atomic bombs on Japan, the 421st NFS was based on the small island of Ie Shima. On 25 November 1945, the squadron moved to Itazuke, Japan and flew P-61s until inactivated on 20 February 1947, when it joined the 347th Fighter Group. This was a significant move for the squadron, as it became part of the famous 8th Fighter Wing. On 10 August 1948, its designation changed to the 68th All-Weather Squadron. The 347th Fighter Group consisted of three all-weather squadrons based in the Far East. They were among the last squadrons in the USAF to turn in their ageing P-61s and re-equip with F-82Gs. The 68th was one of the most publicised squadrons in the Korean War: one of its Twin Mustangs, piloted by Lieutenant William G. 'Skeeter' Hudson, got the first confirmed aerial kill of the war.

On Armed Forces Day at Ashiya Air Base, Japan, 1949, a large crowd showed up to see the 68th's F-61s and its new F-82Gs.

317th FS (All-Weather)

The 317th FS operated as a day fighter squadron with P-47s and P-51s in the MTO and ETO, deactivating in October 1945 and reactivating 'on paper' as an all-weather fighter squadron in May 1947. It seems that their P-61s did not actually arrive until November or December of that year. As part of the 325th Fighter Group with three P-61 squadrons, they operated from McChord, Washington; Hamilton, California; and Moses Lake, Washington. Its tenure with the Black Widow was brief, F-82s arriving at the end of 1948. Like its sister 318th and 319th squadrons, its converted to F-94s when the F-82s left in 1950.

Yellow spinners and aircraft numbers were characteristic of the P-61s of the 317th FS in 1947-48.

319th AWS (ex-414th NFS)

The 414th NFS moved from Italy to California on 19 October 1945 and in mid-August 1946 it settled at Shaw Field, South Carolina. Prior to this move, it was briefly assigned to Air Defense Command at Merced Field, California. In March 1947, the squadron moved to Rio Hato, Panama under the control of Caribbean Air Command, to provide all-weather air defence for Central America. Finally, on 1 September 1947, the 414th was inactivated and its personnel and equipment were turned over to the newly activated 319th All-Weather Squadron. The squadron had traded its F-61s for F-82s by the time it returned to the US in May 1949.

Another open day, this time at Albrook Field in Panama, offered locals a close-up look at a P-61 of the 319th AWS.

339th AWS (ex-6th NFS)

Gertrude V, ***a 339th AWS Black Widow, waits on the ramp at Johnson AB, Japan, formerly Irumagawa airfield. Note the post-1947 national insignia and the lack of a buzz number.***

When the war came to an end, the 6th was scattered all over the Pacific, with detachments on Saipan and at Kipapa Field in Hawaii. As the occupation of Japan got under way, it moved to Atsugi Air Base, Japan. The 6th's aircraft were easily distinguished by a large numeral on the nose. Finally deactivated on 21 February 1947, the squadron's equipment and personnel became the 339th All-Weather Squadron and was attached to the 35th Fighter Wing, based at Johnson AB, Japan. It distinguished itself during the early days of the Korean War, flying the F-82G Twin Mustang.

P-61 Operators

8th PRS

The 8th Photographic Reconnaissance Squadron was formed in January 1942 at March Field with F-4s (P-38s) and served throughout the Pacific. In mid-1947, the squadron existed in name only, having no aircraft. This changed in June with the delivery of the first F-15A Reporters direct from the factory to the 8th's base at Johnson AB, Japan. The squadron was soon involved in the massive job of photo-mapping large areas of the Far East including the Korean peninsula. A detachment was sent to Clark AB in the Philippines in the winter of 1947-48. In August 1948, the unit was redesignated the 8th Tactical Reconnaissance Squadron (Night Photo) and, soon after, the F-51 was also renamed, as the RF-61C. Reporter missions tailed off until March 1949 when the survivors were assigned to the 35th Maintenance Squadron and put out to grass, while the personnel moved to Yokota and took up their new RF-80s.

One of the 8th's detachment F-15As taxis out on another photo mission at Clark AB in the Philippines, passing an F-9 (B-17) of the 5th PRS.

Training squadrons

Initial training for night-fighter crews began in late 1942 with the Army Air Force School of Applied Tactics (AAFSAT) at Orlando Field. AAFSAT's Night Fighter Division parented the 481st Operational Training Group (OTG), which was equipped with a motley collection of aircraft including A-20s, Beaufighters and YP-61s when they became available. The first real P-61 training squadron was the 348th NFS, which joined AAFSAT in July 1943, using YP-61s. The 348th conducted preliminary training, and the 349th NFS at Kissimmee the second phase, involving crew integration and combat training. The 420th NFS took crews to the next stage, training in realistic field conditions from Dunnellon, Florida from August 1943. With the activation of the 424th NFS in November 1943, the 348th and 349th became primary training squadrons and the 420th and 424th took over the advanced syllabus, both squadrons moving to Hammer Field, California from January 1944. In March 1944, all four squadrons were deactivated, with the 424th crews joining the 549th NFS and those of the 420th joining the 547th.

Gremlin's Castle, *a P-61 of one of the four training squadrons, formates over California with a 'short-tail' P-40 named* My Selma.

All-Weather Flying Center

Nine P-61Cs and an F-15A were used for weather research in Project Thunderstorm. The All-Weather Flying Center was based at Pinecastle Field, Florida. Five heavily-instrumented aircraft at a time would penetrate a thunderstorm at different altitudes to take readings. The SCR-720 radar was used to plot thunderstorms and their displays were photographed.

Red and yellow nose and tail markings characterised the aircraft assigned to the All-Weather Flying Center for weather research flying. The* Thunderstorm *name on the nosewheel door of this P-61C-1-NO featured on a number of its aircraft.

USMC

In 1944, the US Navy ordered 75 P-61s with the intention of issuing them to the Marines and re-equipping PV-1 Ventura squadron VMF-531(N). Eleven Marines were sent for training at Cranfield with the RAF. Part of this training included flying operational missions with AAF crews over Europe. The P-61s for the Navy were cancelled, however, when the faster F7F Tigercat became available. At war's end the Marines obtained 12 P-61Bs for use as radar trainers by F7F crews and they were given the Navy designation of F2T-1N (Northrop's first naval fighter, the XFT, had been an unsuccessful low-wing prototype of 1934). The F2Ts were assigned to the Marine Night Fighter Operational Training Detachment at Vero Beach and MAG 53 at Cherry Point. The Navy also tested one aircraft (P-61A 42-39395) at Mustin, Pennsylvania with catapult bridles (but no tailhook) to assess the type's suitability for delivery to the combat zone by flying from aircraft-carriers as had been done with P-40s and P-47s.

This former P-61B was among the F2T-1Ns assigned to the training detachment at Vero Beach.

NACA

The National Advisory Committee on Aeronautics (NACA) flew P-61s and a single F-15 in the period 1944-54. The first aircraft, P-61A 42-5572, was used in 1944 to tow a propellerless P-51B to compare the latter's aerodynamics against the figures obtained from wind-tunnel models. Post-war, NACA Ames acquired two ERF-61Cs, 43-8330 and 43-8357. The former aircraft was bailed from the Smithsonian Institution as NACA 330 (later NACA 111) and used for high-altitude drop tests. The latter was used as a spares source. The prefix in the designation ERF-61C breaks down as: E for Exempt (military aircraft bailed to a non-military agency), R for Restricted (unsuitable for combat), and F for Fighter. E for Exempt was only used in the 1947 period. After the tests, 43-8330 was returned to storage with the Smithsonian (now NASM). NACA Ames also operated a single F-15A (45-59300) which was used for further drop tests over Rogers Dry Lake. In service from 1948 to 1954, the F-15 also adopted the NACA 111 identity. NACA's Lewis facility at Cleveland operated P-61B-15 42-39754 between October 1945 and October 1948, primarily as a ramjet testbed.

NACA's F-15A was supercharger-equipped and was used to carry test bodies up to 40,000 ft (12192 m).

A&AEE

Although the United Kingdom was not technically a Black Widow operator, a single example was evaluated by the Aeroplane & Armament Experimental Establishment (A&AEE) at Boscombe Down in 1944. P-61A-1 42-5496 arrived on 6 May 1944 on loan from the 9th Air Force and was evaluated for its handling characteristics (rather than for its operational effectiveness or as a weapons system). While being considered pleasant to fly and stable in single-engined flight, the A&AEE's report criticised the "over-complicated" cockpit layout and poor pilot view as well as the large trim changes caused by operation of the flaps and undercarriage. The P-61 was returned to the USAAF in February 1945.

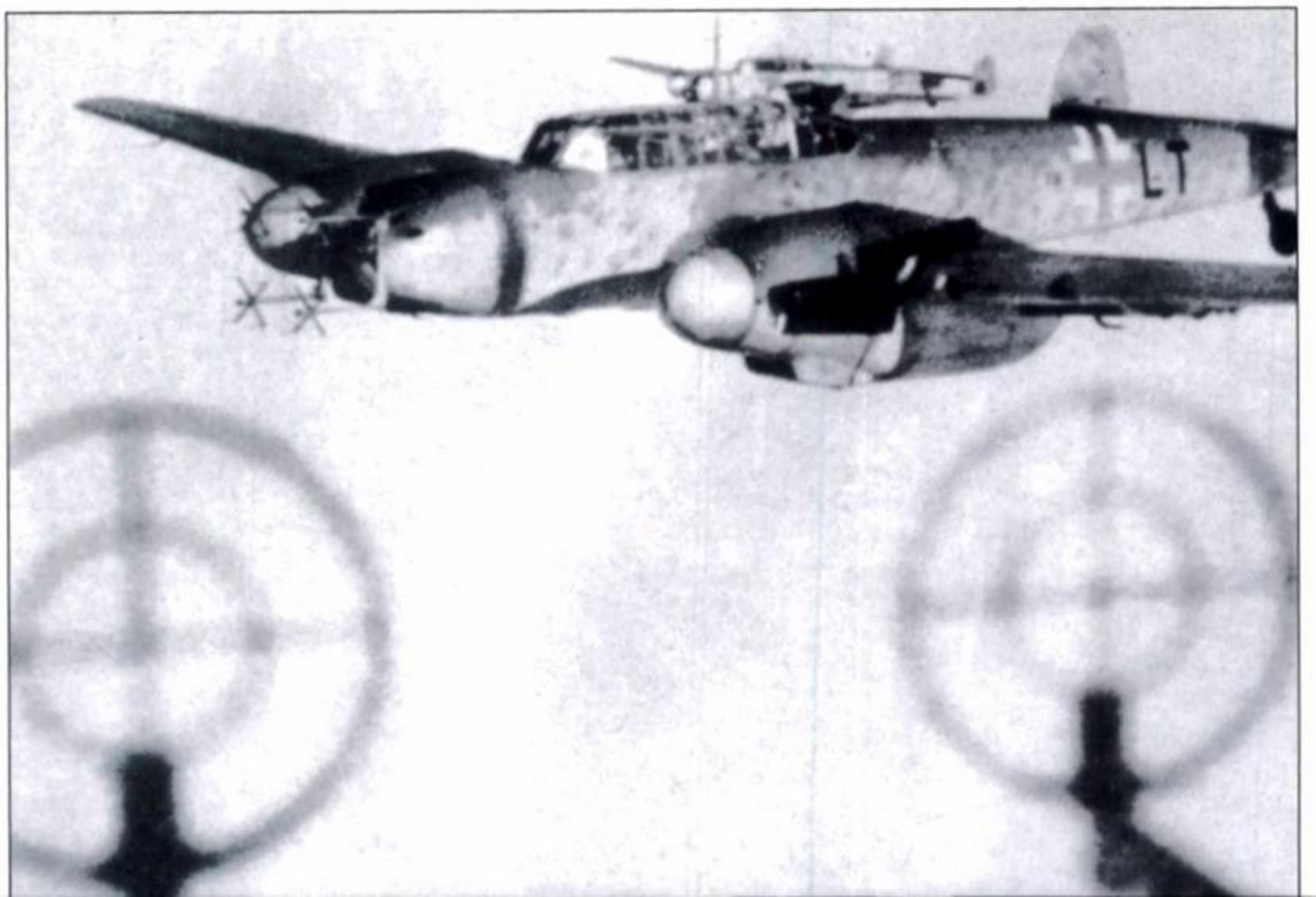
Unlike the other P-61As operated in the ETO, the example tested at Boscombe carried a top turret.

A flight of Saipan-based P-61As, from either the 548th or 549th NFS, cruise over the Pacific, sometime during January 1945. The gun turrets' straight trailing edge indicates fixed installations on these aircraft, although other P-61s without the troublesome rotating unit are known to have used the factory-produced teardrop-shaped housing.

Luftwaffe Nachtflieger

Part 2: May 1942 - May 1945

The 1,000-bomber raid on Cologne, launched on the night of 30 May 1942, marked an important milestone in the RAF's nocturnal offensive against Hitler's Reich. The style of earlier operations, typified by small formations of twin-engined bombers each charting its individual course to a specific target, was now a thing of the past. Henceforth, ever-increasing numbers of four-engined heavies would be 'streamed' across Germany's night skies, eventually culminating in vast armadas capable of obliterating entire cities.



Bf 110G-4s of 9./NJG 3, including 'D5+LT' nearest the camera, are seen on a daylight mission in the summer of 1943. In the foreground are sights belonging to a pair 7.9-mm MG 81Z machine-guns, the photograph evidently having been taken from the gunner's position.

For Bomber Command to regard the raid on Cologne as the 'beginning of the end' was still somewhat premature. Three years of hard campaigning still lay ahead; three years of bitter struggles and fluctuating fortunes – as first one side and then the other met measure with countermeasure – before the Luftwaffe's night-fighter arm was finally laid low. Corroboration of this unpalatable truth was not long in coming. Just 48 hours after Cologne, the RAF mounted another 'maximum effort'. Strictly speaking, the 1 June strike against Essen was not a 1,000-bomber raid; the number of aircraft dispatched fell just 44 short of that total. Results were disappointing as, with the target zone shrouded in mist and low cloud, bombs were scattered over a wide area. Although Bomber Command sustained 10 fewer casualties than it had suffered against Cologne, the loss of 31 bombers was a high enough price to pay for such relatively little return. (As at Cologne, the defending night-fighters lost just one Bf 110 and its crew, the unfortunate pilot on this occasion being 7./NJG 1's Oberleutnant Helmut Woltersdorf.)

On 25 June – the night of the next full moon – Air Chief Marshal Sir Arthur Harris assembled yet a third 1,000-bomber force. Once again,

***Left:** Though new aircraft like the Heinkel He 219 were built to replace the ageing and ill-suited Bf 110s and Ju 88s that formed the backbone of the Luftwaffe's night-fighter force, they were never available in sufficient numbers. Thus the Messerschmitt and Junkers designs remained in production for the duration of the war. This aircraft, a Bf 110G-4, is perhaps typical, equipped with Lichtenstein SN-2b radar and heavily armed with cannon and machine-guns.*

***Right:** This 7./NJG 1 Bf 110G-2 was among the night-fighters put up in daylight to intercept USAAF bombers from early 1943, in what became a very costly tactic for the Nachtjagdwaffe. Note the absence of radar, an unnecessary encumbrance in daylight operations.*

Bomber Command alone could not quite achieve the required number, but with the assistance of Coastal and Army Co-operation Commands, a final total of 1,067 aircraft was made available. The primary objective was Bremen. Although a certain amount of damage was caused, the night's operation cost the attacking forces 55 of their number, 16 being claimed by the Lichtenstein BC-equipped Bf 110s of II./NJG 2. The Nachtjagdwaffe lost two Messerschmitts, and crew members of another two returned wounded.

Satisfied that he had demonstrated his Command's potential, Sir Arthur Harris resumed operations on a less ambitious scale, mounting 100+ bomber raids an average of three or four times a week as he slowly built up his strength.

Ground control shortcomings

On the other side of the North Sea, this trio of historic raids had repercussions beyond the actual physical damage wrought. For the first time, night-fighter aircrews began to express dissatisfaction with their ground control. They went further, questioning the entire concept of a defensive 'front line' made up of a chain of interlocking individual boxes, each capable of controlling only a single night-fighter at a time. The recent bomber streams, designed to penetrate enemy airspace on the narrowest possible frontage, had revealed an inherent flaw in the Luftwaffe's defences: while the fighter in the box was being vectored to an incoming bomber on a 'one-against-one' basis, every other bomber that happened to be passing through that particular box could do so unimpeded.

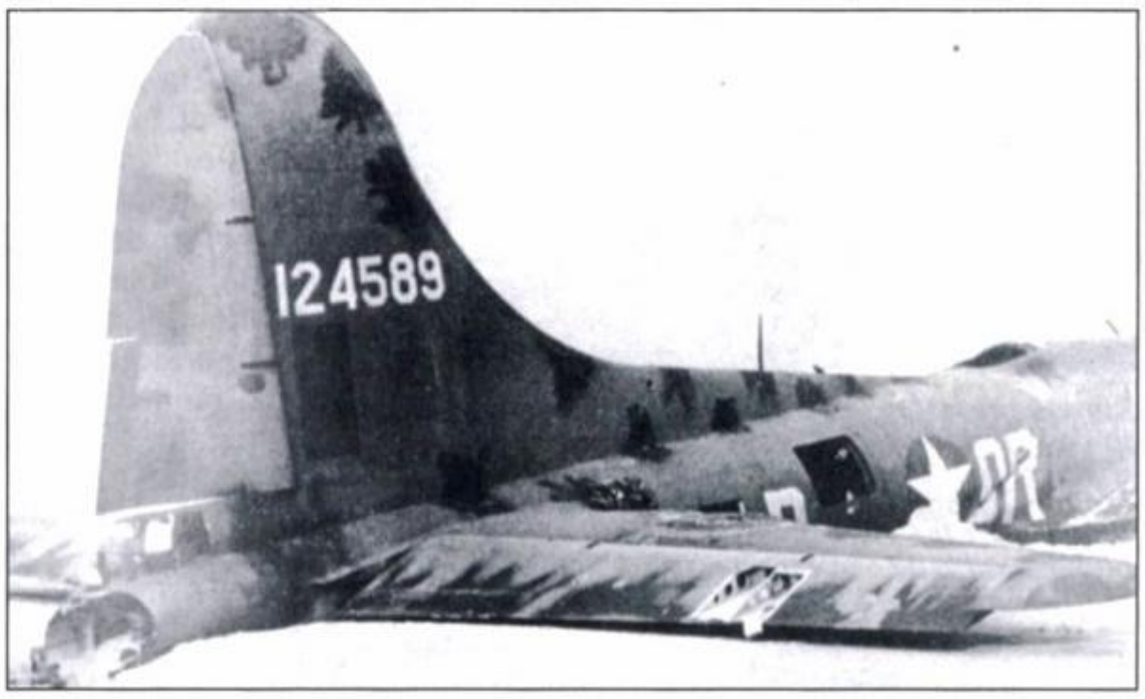
For every night-fighter crew in action, as many as a dozen could be sitting on the ground, fuming, fully conscious of the fact that enemy bombers were passing overhead without hindrance. Talk in the unit messes began to centre on the possibility of introducing some sort of nocturnal equivalent of the day-fighters' *freie Jagd* tactic, whereby pilots were free to roam the skies seeking targets of opportunity. Harris's opposite number, Generalleutnant Josef Kammhuber, GOC Luftwaffe night-fighter forces, would have none of it, though. Prior to the Cologne raid Kammhuber's original Nachtjagddivision had been elevated to the status of a Fliegerkorps (XII.Fliegerkorps, initially comprising three night-fighter divisions, later raised to five). The few Staffeln available to him at the start of the campaign, which he had been forced to "shuffle around like chess pieces in the wake of Bomber Command's early incursions" (as Kammhuber put it in a post-war interview), had since grown to four Geschwader. Forming the central core of his defensive line, many of their component Gruppen had now taken up residence at established bases in northwest Europe which would remain their permanent stations until the final German withdrawal from France and the Low Countries in the latter half of 1944.

Kammhuber was not about to dismantle this carefully structured edifice on the evidence of just three enemy raids. He was convinced the RAF would not be able to sustain its offensive at such a level but would revert to its hitherto slow and steady expansion. He planned to do the same by thickening his defensive line, thus forcing the enemy's bombers to fly through not just one or two, but a whole succession of night-fighter boxes.

To this end he demanded that industry more than double its current monthly production output of 30 Giant-Würzburg radars, stipulating a requirement for 600 additional units by September 1942. He also wanted his existing number of Nachtjagdgeschwader doubled to eight, and an additional 150,000 personnel assigned to XII.Fliegerkorps. Such demands were by no means beyond the realms of possibility and, had they been implemented, would have been keenly felt by Bomber Command.

But – the Defence of the Reich organisation did not yet command the priority later accorded to it. Reichsmarschall Göring dismissed Kammhuber's 'shopping list' as Utopian, rejecting it out of hand. The Luftwaffe High Command was of the opinion that its night-fighter arm as currently composed – and subject to the modest plans for expansion already in place – was more than adequate for the task in hand. There were valid grounds for such an assumption, e.g., the aircrews' acceptance of, and success with, the new Lichtenstein airborne radar was beginning to pay dividends.

As yet, however, only those Gruppen based in the Low Countries and in the path of Bomber Command's main routes of approach (the aforementioned II./NJG 2, plus I. and II./NJG 1) were anything like adequately equipped. Among the other Gruppen, including those of NJG 3 stationed in northern Germany, only experienced formation leaders such as Staffelkapitäne enjoyed the benefits of



***Right:** Texas Bronco was a B-17F of the 323rd Bomb Sqn, 91st BG, reportedly shot down by Hauptmann Hans-Joachim Jabs, then a Staffelkapitän of IV./NJG 1 and another of the pilots to make his mark, during a raid on Emden on 4 February 1943. It was to be Jabs's only four-engined kill of 22 made by day (most during earlier service as a Zerstörer pilot with II./ZG 76). Four-engined 'heavies' figured more prominently among his 28 night kills.*

This Halifax B.Mk II of No. 102 Sqn was brought down by a Luftwaffe night-fighter in the early hours of 26 June 1943, crash-landing near Den Helder in the Netherlands with the loss of all on board. The crew's target had been Gelsenkirchen, an 'oil target' in the middle of the Ruhr.

Sayn-Wittgenstein: 'fighting prince'

Hauptmann Prinz Heinrich zu Sayn-Wittgenstein flew this Ju 88C-6 in early 1943 while Gruppenkommandeur of IV./NJG 5 at Leipheim. Equipped with FuG 202, the aircraft sports a 'dull-down' version of the then-standard black night-fighter colour scheme. Note the kill markings applied over the Hakenkreuz – a common practice with Ju 88 units.

Sayn-Wittgenstein was killed on the night of 21 January 1944, having been made Geschwaderkommodore of NJG 2 at Stendal just three weeks before. His personal aircraft had been damaged in an earlier combat and he is believed to have been flying this 4. Staffel Ju 88C-6 on the night of his death.

Among the rising stars of the Nachtjadgwaffe as the war progressed was Prinz Heinrich zu Sayn-Wittgenstein. Though he was killed almost 18 months before the end of the war, by the end of the conflict the Danish-born prince had the third-highest kill tally of all the Luftwaffe's night-fighter* Experten, *with 83 kills.

Lichtenstein. The incomplete NJG 4 in the southern sectors of the Reich fared even worse, while school establishments came a poor last. (This latter meant that many 'trained' backseaters were arriving at their operational postings completely unversed in what was intended to be the main tool of their trade!)

No reinforcements

Denied the reinforcements in men and material he had demanded, Kammhuber fell back on his own resources. The shortage in manpower was partly resolved by combing through other organisations – Party, Labour Service and Youth – to attract volunteer auxiliaries, both male and female. This resulted in the first large influx of Luftwaffenhelferinnen – the German equivalent of WAAFs – who would henceforth shoulder an ever-increasing burden of non-combatant duties within the Luftwaffe.

The limitations imposed by Himmelbett's system of singleton control could also be partially overcome, if and when the occasion demanded, by combining the activities of the night-fighters in three adjacent boxes. As each box overlapped its two immediate neighbours on either side by some 25 per cent, it was possible to control three fighters simultaneously in an area half as wide again as a standard box (but only at the expense, of course, of the outlying 75 per cent of each flanking box, which was completely denuded). Although only a stopgap measure, such 'enlarged' boxes could prove very effective; a number of Bomber Command aircraft fell victim to them while en route to the Ruhr during the summer nights of 1942.

The night-fighter crews' growing expertise and confidence in their Lichtenstein radar continued to exact a steadily rising toll of enemy bombers. Well over half of all radar intercepts now resulted in kills, and in August 1942 Hauptmann Walter Ehle's II./NJG 1 alone claimed 25 victories using Lichtenstein. August was also the month in which the Luftwaffe introduced a powerful new jamming transmitter, codenamed Heinrich, which effectively swamped the navigational Gee signals used by Bomber Command to fix the position over enemy territory. By this time, too, the early warning chain of coastal Freya radar stations was being augmented by longer-range Wassermann and Mammut installations, which were able to pick up RAF bombers while they were still over England.

In addition to these electronic innovations, moves were being made to increase Kammhuber's operational strength. In August I./NJG 2, the original intruder Gruppe which had operated over the UK in 1940-41, returned from its deployment in the Mediterranean and North Africa. For the next few months it would be based at Melsbroek in Belgium, before decamping southwards again early in

This Ju 88R-1, 'D5+EV' of IV./NJG 3, arrived at Dyce, near Aberdeen in Scotland, on 9 May 1943, flown by a defecting crew from its base in Norway. The first Ju 88 night-fighter to fall into British hands, the aircraft presented the Allies with a complete FuG 202. Extensive flight testing took place, not only to ascertain the overall capabilities of FuG 202, but also to trial the effectiveness of Window in jamming the radar. They showed the German AI radar was comparable to the British AI.Mk IV, though it used a narrower beam which made the tracking of small target movements somewhat easier. Here the aircraft is seen some time later, with an RAF serial (PJ876) and its Lichtenstein BC antenna removed. Today this aircraft may be seen at the RAF Museum, Hendon.

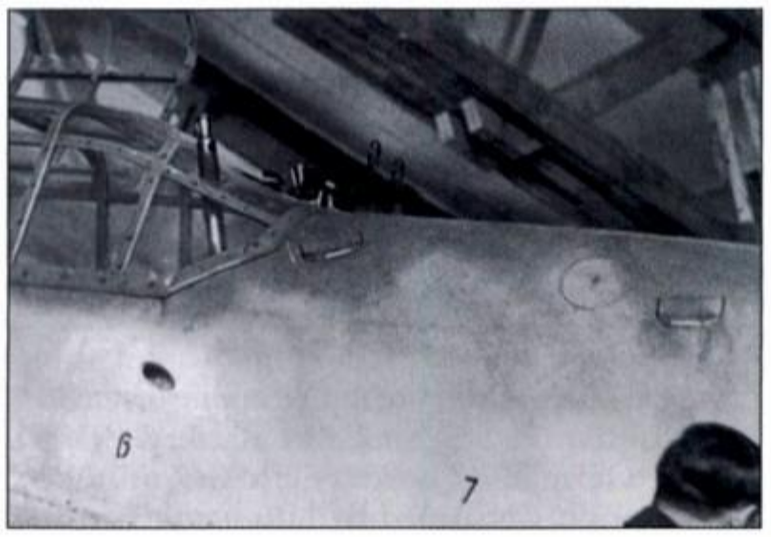
1943. September 1942 brought the beginnings of a completely new Nachtjagdgeschwader in the Berlin area. Initially only Stab and I./NJG 5 were activated, the former at Döberitz under Major Fritz Schaffer, the latter – created around a cadre from the ex-II./NJG 2 – at Stendal under the command of Hauptmann Siegfried Wandam.

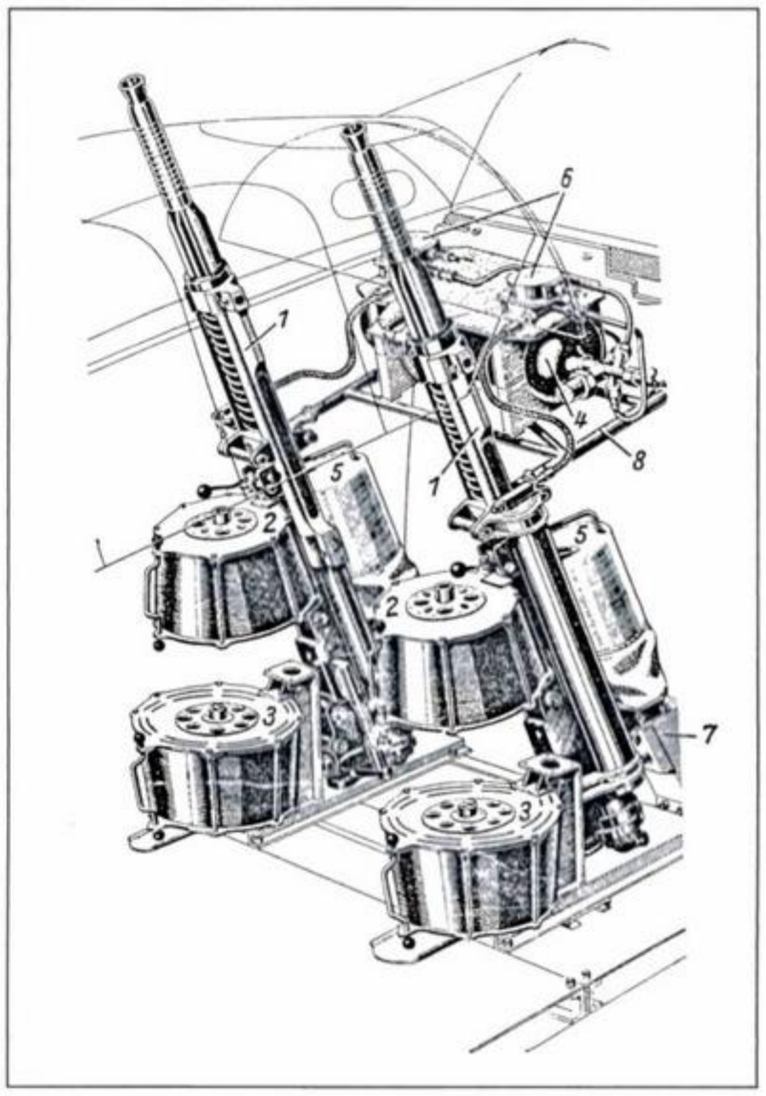
1,000 Nachtjagdwaffe kills

On the night of 10/11 September 1942, one of the 33 bombers lost on a raid against Düsseldorf provided the Nachtjagdwaffe with its 1,000th kill of the war. The remainder of the year was spent bringing each of the nocturnal Defence of the Reich Geschwader up to a new, increased four-Gruppe establishment. The first unit to be thus reinforced was NJG 1, whose IV. Gruppe was created on 1 October at Leeuwarden by the simple expedient of redesignating that base's current resident, Hauptmann Helmut Lent's II./NJG 2. (The vacant II./NJG 2 slot was promptly filled by redesignating III./NJG 2. Under its new guise, this Gruppe was then transferred to the Mediterranean.) October 1942 had also finally witnessed the activation of I./NJG 4 (II. and III. Gruppen having been formed in the spring). A IV./NJG 4 would be added on 1 January 1943. Prior to that date, however, three further Gruppen had come into being: IV./NJG 3 and II. and IV./NJG 5. By the turn of the year the forces deployed by Kammhuber in direct Defence of the Reich thus numbered a not inconsiderable 15 Nachtjagdgruppen: three Geschwader (NJGs 1, 3 and 4) of four Gruppen each and one (NJG 5) of three, III./NJG 5 not being activated until April 1943.

Among the aircrew of these Gruppen, new names and personalities were beginning to emerge. Alongside such stalwarts as Falck, Streib and Lent, other names were becoming familiar to the general public as individual scores mounted and decorations were promulgated. Of the 10 Knight's Crosses awarded to the night-fighter arm in 1942, two went to foreign-born princes.

Kommandeur of I./NJG 3, Hauptmann Egmont Prinz zur Lippe-Weissenfeld had begun his military career flying with the Austrian Luftstreitkräfte. Having received the Knight's Cross on 16 April 1942 for 21 victories, he would add 30 more – and be awarded the Oak Leaves – before becoming Kommodore of NJG 5 in February 1944. That, his final command, lasted exactly three weeks: Major Egmont Prinz zur Lippe-Weissenfeld and his two crew members all lost their lives when their Bf 110G-4 struck high ground near St Hubert in the Belgian Ardennes during a non-operational daylight flight on 12 March 1944.

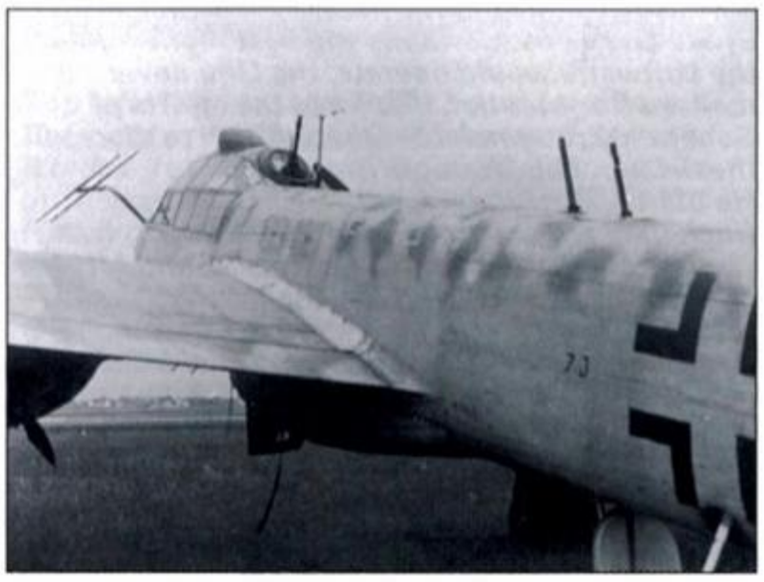




The introduction of* schräge Musik *was championed by NJG 1's Rudolf Schönert as early as 1941 as an easier way of aiming at and hitting enemy bombers. It became a common fit on Bf 110 night-fighters (above). Note the twin MG 81Z ring sights still* in situ*; Bf 110Gs usually retained their MG 81Z installation when fitted with an oblique pair of MG FF cannon (right). A similar fit was also designed for the Ju 88G (below right).

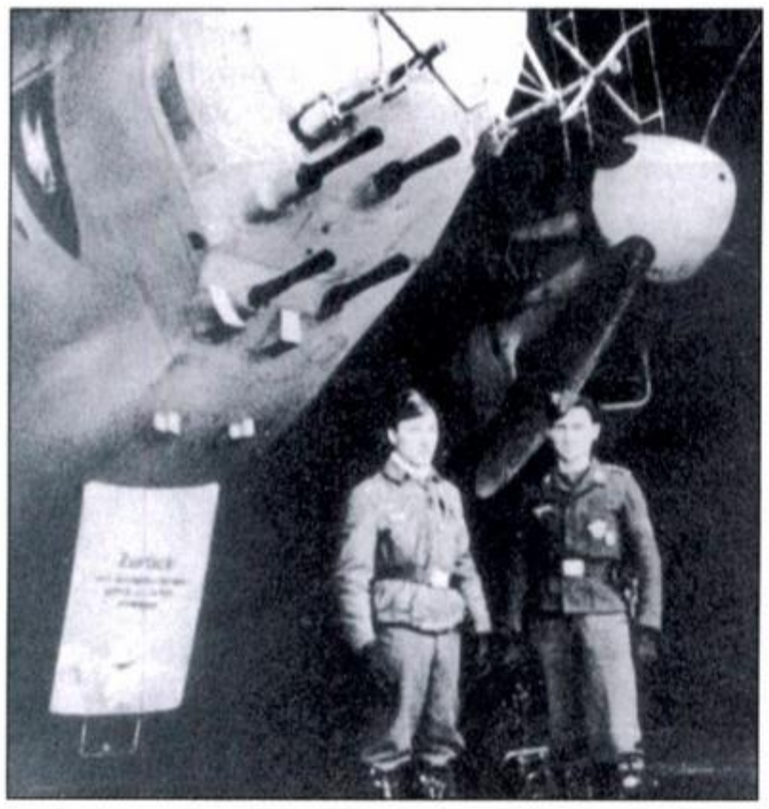
Born in Denmark and brought up in Switzerland, Hauptmann Heinrich Prinz zu Sayn-Wittgenstein – a descendant of a famous Russian field marshal in the Napoleonic wars – had been awarded his Knight's Cross on 2 October 1942 when his score stood at 22. Appointed Kommandeur of the newly-activated IV./NJG 5, he would become even more successful than Lippe-Weissenfeld. He received the Oak Leaves on 31 August 1943 for 47 kills before promotion to the command of NJG 2 on 1 January 1944. By a strange quirk of fate, his tenure of office as a Geschwaderkommodore would also last precisely three weeks: Major Heinrich Prinz zu Sayn-Wittgenstein was killed in action on the night of 21 January 1944. His total of enemy aircraft destroyed at the time of his death was 83, making him the third-highest-scoring night-fighter pilot of the war, behind only Schnaufer and Lent. He was posthumously honoured with the Swords to his Oak Leaves.

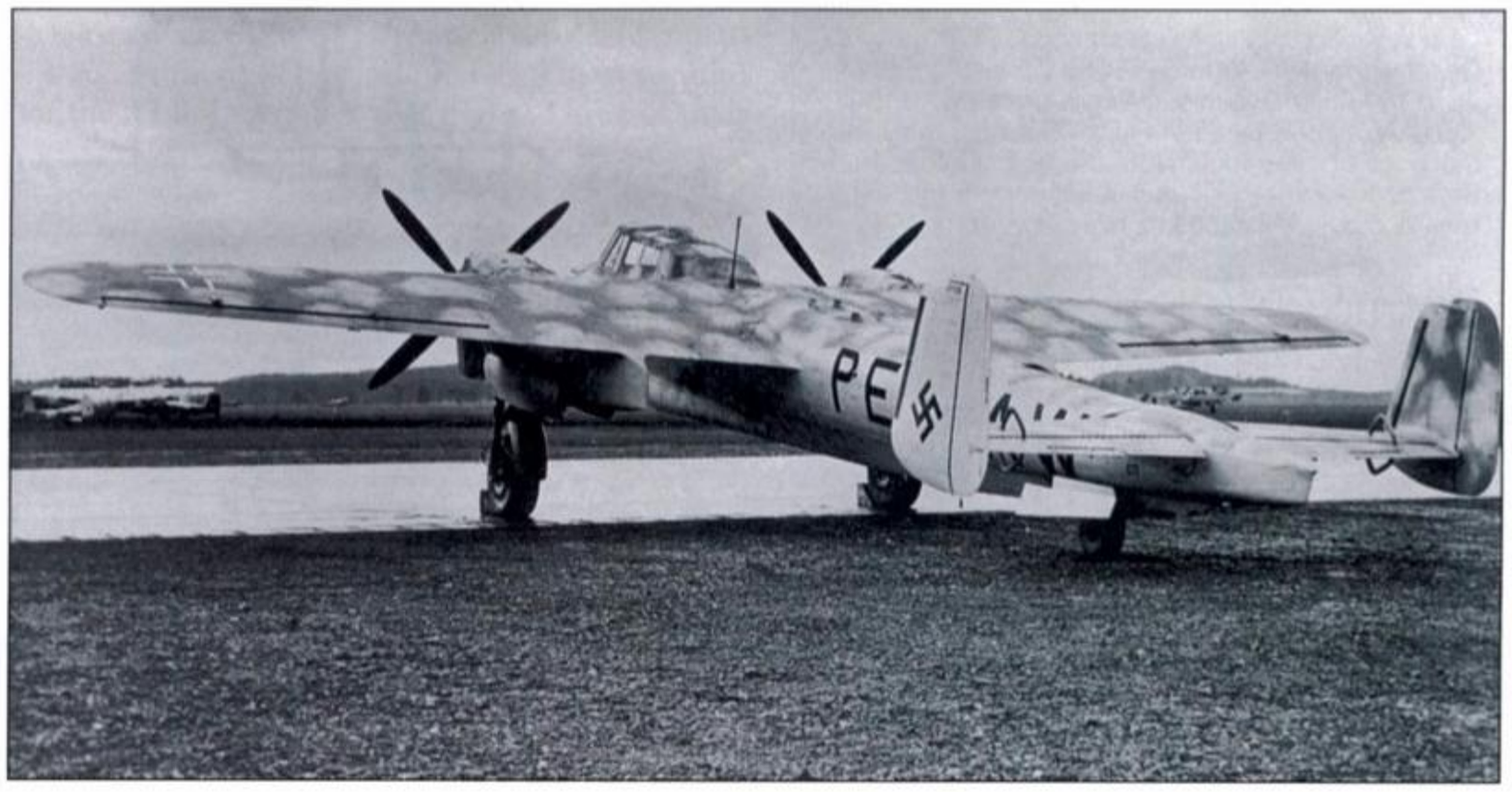
1942 had been a year of consolidation rather than major innovation on both sides of the

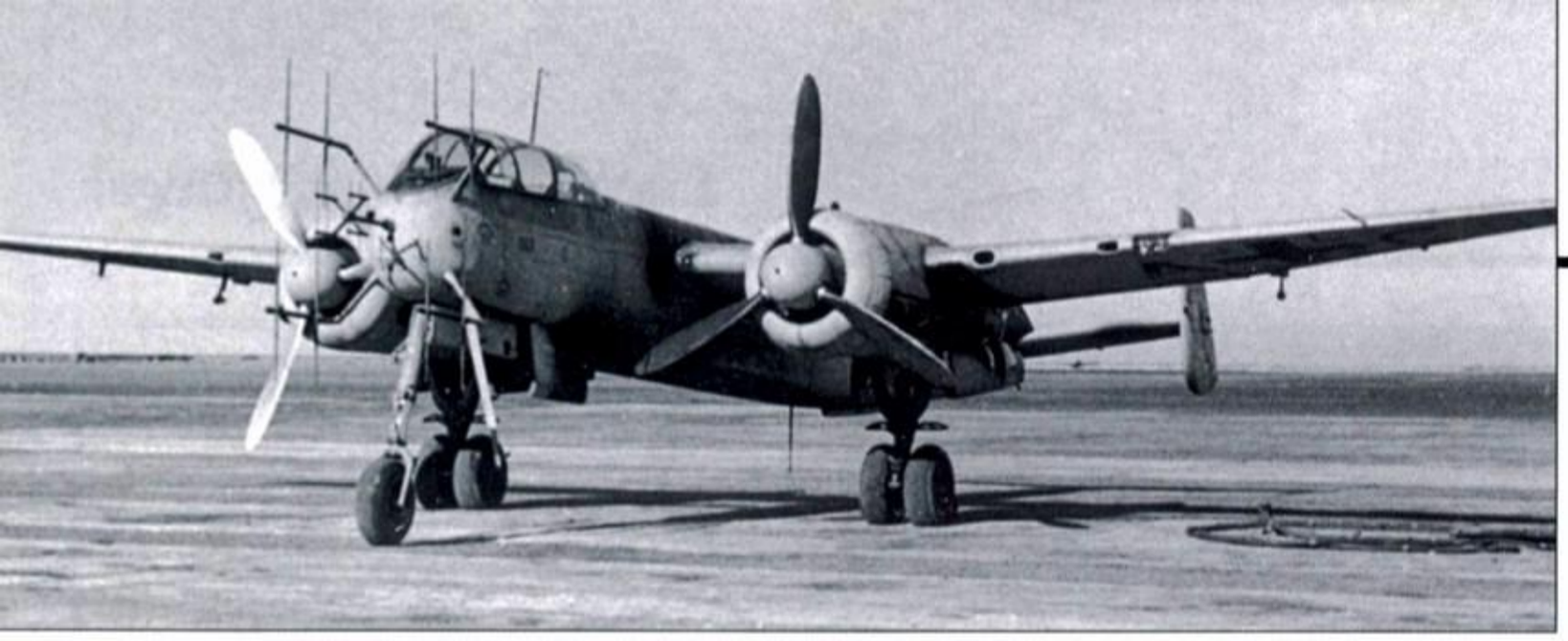


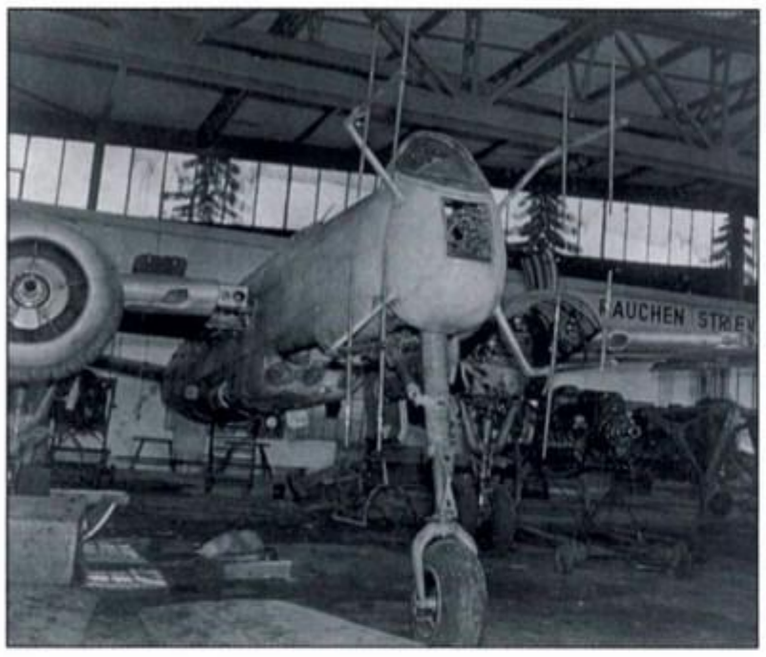
Below left: Though unpopular with crews and destined for only a short period of service with the night-fighter force, the Dornier Do 217 was a large, heavily-armed aircraft, as can be seen in this view of a Do 217N with FuG 202 and an eight-gun armament fit (four cannon and four machine-guns). Most were passed to II./NJG 4 in 1943.

Below: The last of the Do 217 night-fighters was the Do 217N-2, with a quartet of MG 151 cannon in the rear fuselage.









Top: With the Focke-Wulf Ta 154, Heinkel's He 219 Uhu was an attempt to build a modern purpose-designed night-fighter to replace the Bf 110 and Ju 88. Certainly the best night-fighter the Luftwaffe would operate, the Uhu never realised its potential, thanks to the efforts of Generalluftzeugmeister Erhard Milch to discredit the design. This example is equipped to He 219A-5/R1 standard, with an SN-2b array (including a Lichtenstein C-1 Weitwinkel), two 20-mm MG 151/20 cannon and two 30-mm MK 108 cannon.

Above: In this view of a Uhu "captured intact at Bindbach, near Bayreuth" by the US Army, some of its novel features can be seen, including its tricycle landing gear, belly gun pack and slim fuselage.

North Sea, but in those 12 months the seeds of the Nachtjagdwaffe's final defeat had been sown. The RAF had introduced two new aircraft into service. Although not yet operational in any great numbers, the Lancaster and the Mosquito would ultimately prove to be war winners in the night skies over Germany.

On 27 January 1943 the reality of a round-the-clock bombing offensive against the Reich came one step closer when, for the first time, B-17s of the US 8th Air Force attacked a target within Germany's borders. In the mistaken belief that heavily armed Bf 110s would provide a useful addition to their thinly-stretched daylight fighter defences, the Luftwaffe High Command ordered that local night-fighters should be sent up against the next such raid. It was not long in coming.

Some 60+ B-17s were dispatched against Emden in north Germany on 4 February 1943. Hauptmann Hans-Joachim Jabs led eight Bf 110s of IV./NJG 1 up from Leeuwarden to intercept them. Although the night-fighters claimed three of the five bombers lost that day, they themselves suffered heavily: two Messerschmitts reportedly failed to return and the remaining six were all badly damaged. Despite these losses, and others even more serious in subsequent actions of a similar nature, the High Command continued to insist that night-fighters be used to engage American daylight raids in times of need. The only concession Kammhuber could later extract from his superiors was that the more experienced formation leaders should be prohibited from taking part – yet these were the very men, many of them ex-daylight Zerstörer pilots, who could perhaps have achieved some success. Nonetheless, it was the mainly inexperienced 'rank and file' aircrews, the majority versed only in night-fighting tactics, who continued to be thrown against the American heavies by day. Their losses were proportionate. Such missions were flown until early 1944, when the growing number of US escort fighters finally rendered them prohibitive.

February 1943 was a bad month for the Nachtjagdwaffe, with three Knight's Cross holders losing their lives. On the eve of the Emden raid, Hauptmann Reinhold Knacke, Staffelkapitän of 3./NJG 1, had been shot down over Holland. A leading night-fighter exponent since the earliest days, Knacke's final tally of 44 kills included five claimed in a single night. On 24 February, after two fruitless pursuits in night-fighter sector 'Hamster', Oberleutnant Paul Gildner of NJG 1 was ordered to return to base as the weather in the area was deteriorating rapidly. En route, his port engine exploded, tearing off the aircraft's Lichtenstein nose radar array. Despite this he made it back to Gilze-Rijen, where he ordered his wireless operator to bale out. Too low by then to follow suit, Gildner attempted an emergency landing, but his Bf 110 spun in from a height of 200 m (656 ft). Coincidentally, Paul Gildner, whose Knight's Cross had been awarded in July 1941 for 14 nocturnal kills, had since added another 30 to bring his final score to 44, too.

The third *Experte* lost in February was Hauptmann Ludwig Becker, shot down in a daylight action against US bombers attacking Wilhelmshaven on 26th. Becker had received his Knight's Cross on 1 July 1942 (the same date as Knacke) and his Oak Leaves – for 46 night victories – were announced on the very day of his loss. Knacke and Gildner were both posthumously honoured with the Oak Leaves.

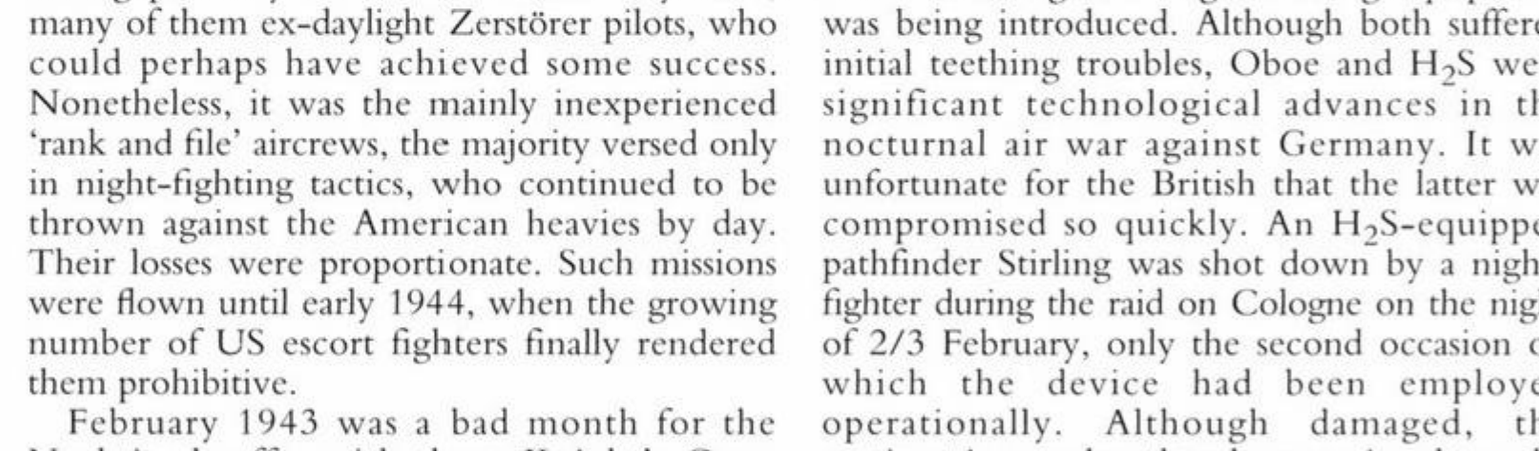
Bomber Command introduces H_2S

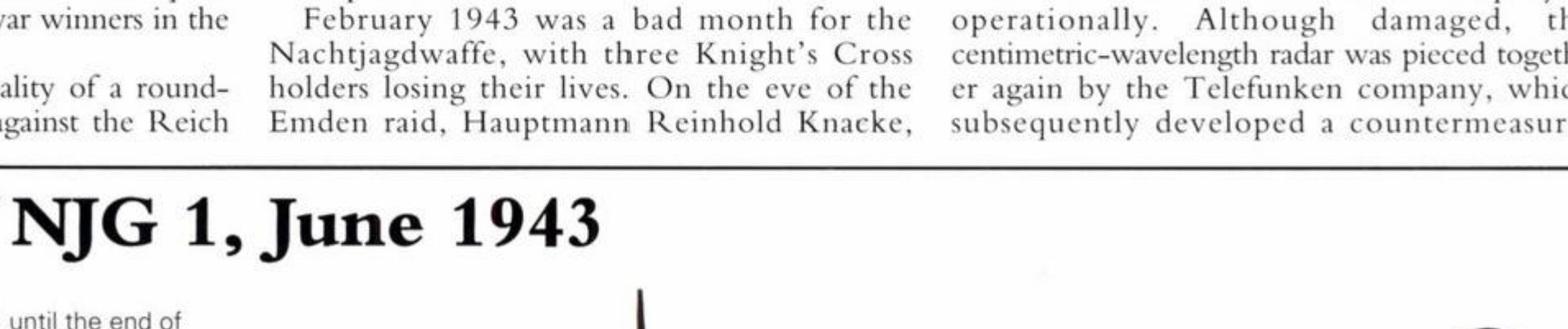
By early 1943 Harris's first-line strength comprised 900 bombers, approximately two-thirds of which were four-engined, with 30 being Mosquitos. More importantly, perhaps, in place of the now-defunct Gee, new airborne blind-bombing and target-finding equipment was being introduced. Although both suffered initial teething troubles, Oboe and H_2S were significant technological advances in the nocturnal air war against Germany. It was unfortunate for the British that the latter was compromised so quickly. An H_2S-equipped pathfinder Stirling was shot down by a night-fighter during the raid on Cologne on the night of 2/3 February, only the second occasion on which the device had been employed operationally. Although damaged, the centimetric-wavelength radar was pieced together again by the Telefunken company, which subsequently developed a countermeasure,

Fighters of NJG 1, June 1943

Oberst Wolfgang Falck was the Geschwaderkommodore of NJG 1 until the end of June 1943. His Geschwaderstab aircraft, Bf 110C 'G9+AA', was finished in typical night-fighter markings of the period. Note the lack of colour in the Stab code letter; there was little need for this extra means of identification in a night-fighter!

Major Werner Streib, Gruppenkommandeur of Stab./NJG 1 in June 1943, was given the task of forming a flight within NJG 1 with which to test the He 219 Uhu in combat. 'G9+FB' was He 219 V9 and took part in the type's first combat sortie on the night of 11/12 June. Famously, Streib shot down no fewer than five RAF bombers on this first mission, though the aircraft was wrecked in a crash landing upon its return to Venlo.





Naxos, that permitted night-fighters to home in on bombers whose H_2S sets were in use. In addition to Oboe and H_2S, RAF machines were also being fitted with a raft of other devices: Boozer and Monica gave warning of enemy air and ground radar activity; Mandrel and Tinsel were jamming transmitters.

Harris used this electronic armoury to launch the Battle of the Ruhr, a five-month offensive against German industry which began with a heavy attack on Essen on the night of 5/6 March 1943. The Nachtjagdwaffe found itself beset on all sides: the Würzburg early-warning coastal radar sites reported jamming for the first time; the night-fighters' own ground control organisation was suffering likewise; in the air, the enemy bombers held the technological advantage. Now, Mosquito intruders were beginning to attack the night-fighters' own bases.

Once again it was NJG 1, astride the direct flight path to the Ruhr targets, which bore the brunt. On the night of 12 March, for example, II./NJG 1 at St Trond was strafed by a dozen Mosquitos. Standing night-fighter patrols were flown in an attempt to curb this growing menace, but to little effect. There was, however, the occasional success, as when Helmut Lent, Kommandeur of IV./NJG 1, and one of his Staffelkapitäne – 12./NJG 1's Oberleutnant Lothar Linke – each claimed a Mosquito intruder downed on successive nights in April. Such was the pressure being exerted on NJG 1 during this period that experienced crews from other units further afield were seconded to the hard-pressed Geschwader's bases in Holland and Belgium. (Thirteen of the 22 victories claimed by II./NJG 1 during the month of June were credited to these 'temporary' draftees.)

Kammhuber's ambitious demands

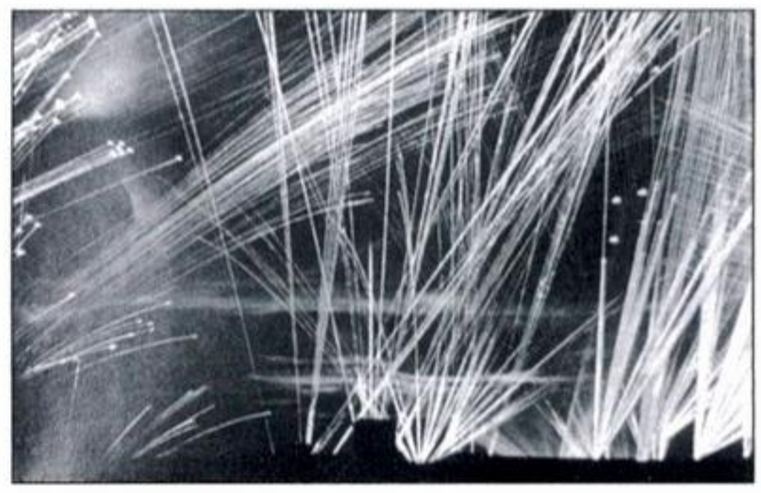
Faced with this onslaught, Generalleutnant Kammhuber had no answer but to reiterate his earlier request for an increase in strength. This time his demands were even more ambitious. He envisaged a Jagdflotte (fighter fleet) organised along the lines of the RAF's Fighter Command and comprising no fewer than 18 Jagdgeschwader – over 2,000 aircraft in all, four times the number of his present force!

Bomber Command's offensive against the Reich was obviously beginning to have an impact, for Kammhuber received the immediate and unequivocal support of Hermann Göring. Together, Marschall and General were received by Adolf Hitler on 25 May 1943. Kammhuber was not even allowed to finish outlining his plans. His projected figures for future Allied aircraft production were completely wrong, the Führer pronounced. Germany's defences were in excellent shape and were exacting a crippling toll on the aggressors. The proposal was summarily rejected.

Rather than backing his subordinate, Göring had remained silent throughout. After the audience was over the Reichsmarschall rounded angrily on Kammhuber, accusing the latter of placing him in an impossible position with the Führer. According to Aders's history of the night-fighter force (*Geschichte der Deutschen Nachtjagd 1917-1945*, Stuttgart 1978), Göring worked himself up into a state of near apoplexy and finally screamed at Kammhuber, "You are completely mad. You want the entire Luftwaffe. You might as well sit at my desk right now and be done with it!" The Reichsmarschall was not a man to be crossed or slighted. This incident marked the start of Kammhuber's fall from favour. The Luftwaffe High Command knew – even if Hitler did not – that the rigid adherence to the Himmelbett system was not producing the desired results, let alone inflicting 'crippling' losses on the enemy. Nor were they prepared to accede to Kammhuber's demands for such huge increases in numbers. The siren song of those, on the other hand, who were advocating the use of single-engined fighters in a sort of nocturnal *freie Jagd* capacity was beginning to receive serious consideration.

In the meantime, Bomber Command was pursuing the Battle of the Ruhr with all the means at its disposal. Arguably the most damaging raid mounted during this period was that directed against Wuppertal on the night of 29/30 May 1943: over 700 bombers were dispatched, some 150 of which, it is estimated, overflew II./NJG 1's defence sector. Thirteen Bf 110s of Major Walter Ehle's Gruppe were sent up to intercept them. They claimed exactly one-third of the 33 bombers lost that night. Three of their

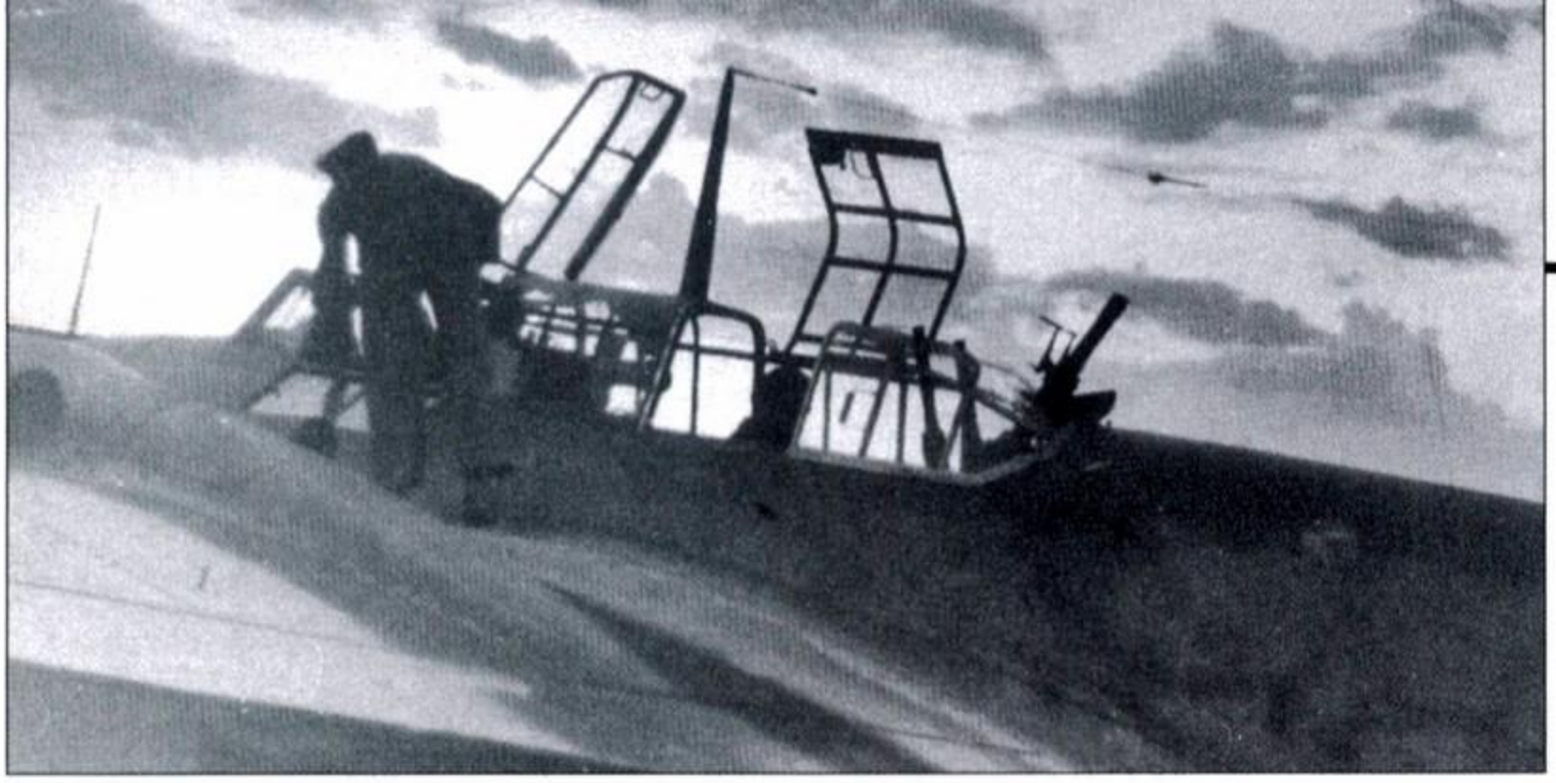
Left: Single-seat aircraft were among the first Luftwaffe night-fighters and came into their own once more as the conventional force attempted to recover from the effects of Window on its ground-based and airborne radar. Here a pilot on Wilde Sau operations hops from his Fw 190 after such a sortie. Wilde Sau operations were particularly hazardous, taking place as they did amid the intense fire put up by flak batteries defending the bombers' targets.



Top left: The massive RAF raid on Hamburg on the night of 24/25 July 1943 saw the first use of Window to jam German radar. This impressive display of pyrotechnics was reportedly part of Hamburg's flak defences that night.

Top and above: Light flak groups ineffectively at lower altitude, while heavier-calibre bursts dot the sky above the city. Heavy undirected flak barrages like this claimed just three RAF bombers on 24/25 July.

Below: Oberst Hajo Hermann (seen here wearing a Knight's Cross, Oak Leaves and Swords), was the originator of Wilde Sau tactics. Hermann was awarded his Knight's Cross in 1940 while a bomber pilot with KG 4 and was later a Staffelkapitän in III./KG 30. In 1942 he joined the Luftwaffenführungsstab (Operational Staff).



Above: The pilot of a radar-equipped Bf 110 prepares for the coming night's sortie as the evening sun begins to set.

This is Hauptmann (later Major) Friedrich-Karl Müller, Technical Officer of JG 300. An ex-Lufthansa pilot, Müller later commanded 1./NJG 10 and I./NJG 11 and was nicknamed 'Nasen-Müller' (literally, 'Nose Müller') not only on account of his physical characteristics, but also to tell him apart from day fighter **Experte** *Friedrich-Karl Müller, the 140-kill ace who flew with JGs 3 and 53.*

11 victims fell to the guns of just one man – a promising 21-year-old Leutnant named Heinz-Wolfgang Schnaufer.

In addition to the 13 Bf 110s, II./NJG 1 had also scrambled a trio of Do 217Js (two of which were lost), for, at long last, the Luftwaffe had been provided with a 'new' night-fighter to supplement the Bf 110s and Ju 88s – and, to a lesser extent, the earlier Dornier Do 17s and 215s – which had equipped the Nachtjagdwaffe to date. The Do 217 was very much a stopgap measure, however. Dornier had simply bolted a solid nose onto an existing bomber design and fitted an additional fuel tank in the forward bomb bay. Otherwise, the Do 217J-1 retained all the equipment of the standard E-2 bomber, including dorsal and ventral gun positions, bomb-release gear, dive brakes and rubber dinghy! The weight of all these unnecessary items, together with the additional nose armament, meant that the Do 217J-1 night-fighter was nearly 1 ton heavier than its bomber counterpart and, in the Luftwaffe vernacular of the time, was regarded as an extremely 'tired crow'. The Luftwaffe tried to put matters right itself, stripping out all the excess and unwanted equipment, which resulted in a marked increase in performance. This was reported back to Dornier, only to receive more of the same.

The Do 217N-1 night-fighter was another makeshift bomber conversion, differing from the E-2 only in its powerplants (DB 603As in place of the latter's BMW 801s). The definitive, aerodynamically-refined Do 217N-2 could have proved a useful addition to the night-fighter arm had it not been tainted with the dislike engendered by the earlier models.

Despite being widely distributed among front-line units (it served with about a dozen Gruppen in all, invariably being assigned to the most junior and inexperienced aircrews), the Do 217's lack of numbers meant that it remained something of a 'rare bird'. The unfamiliar shape of the Dornier in the night skies over Germany resulted in more Do 217s being shot down by 'friendly' night-fighters than any other type. It was a notoriously lame bird, too, suffering – as did many German aircraft designs – from shortages and bottlenecks in powerplant production. Despite cannibalisation, it was not uncommon for there to be more aircraft unserviceable awaiting replacement engines or spare parts than there were machines operational. At one point in July 1943, all 14 of II./NJG 3's Do 217Ns were grounded with engine defects, while the Gruppe continued to wage war with its seven remaining Bf 110s.

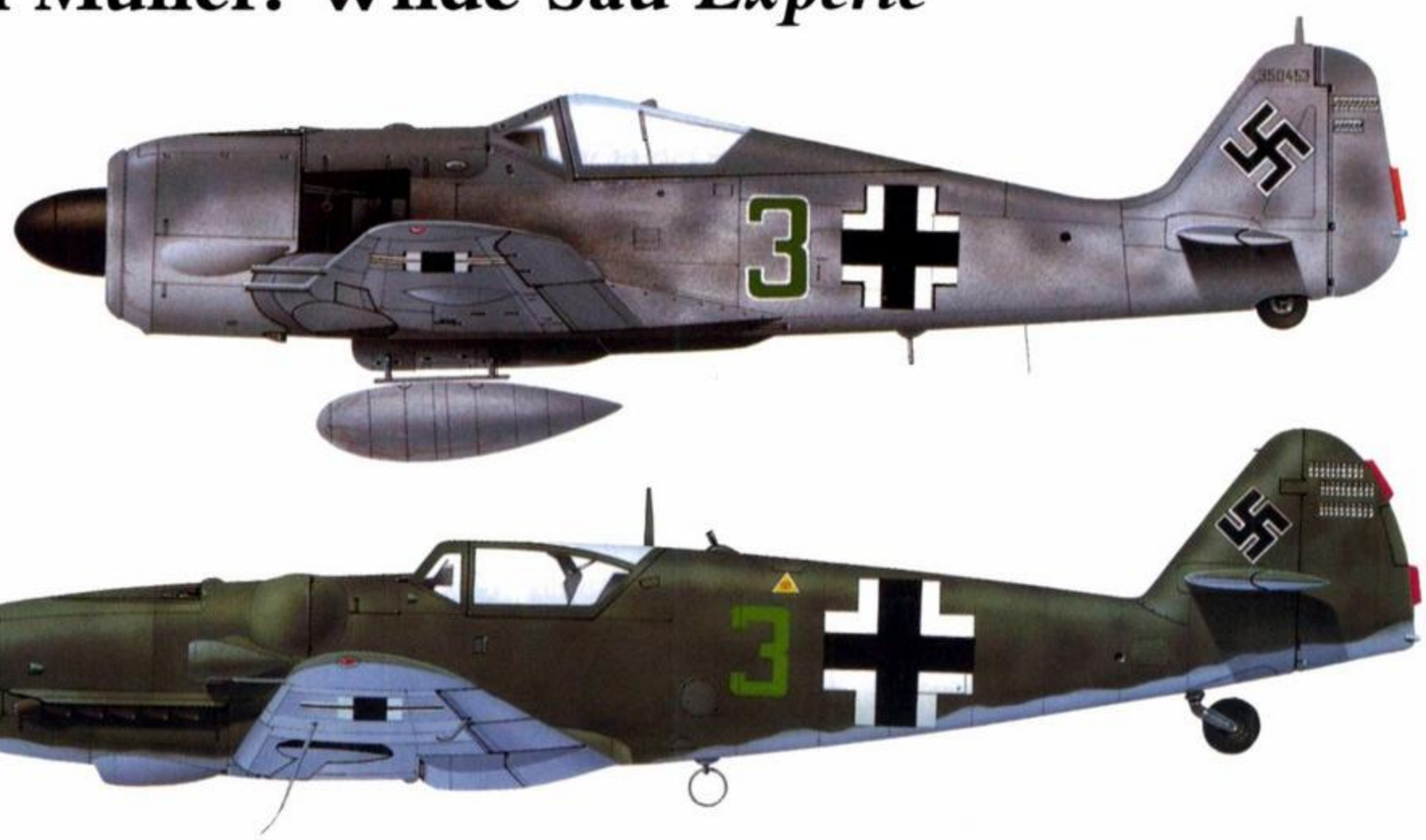
Schönert – Do 217 champion

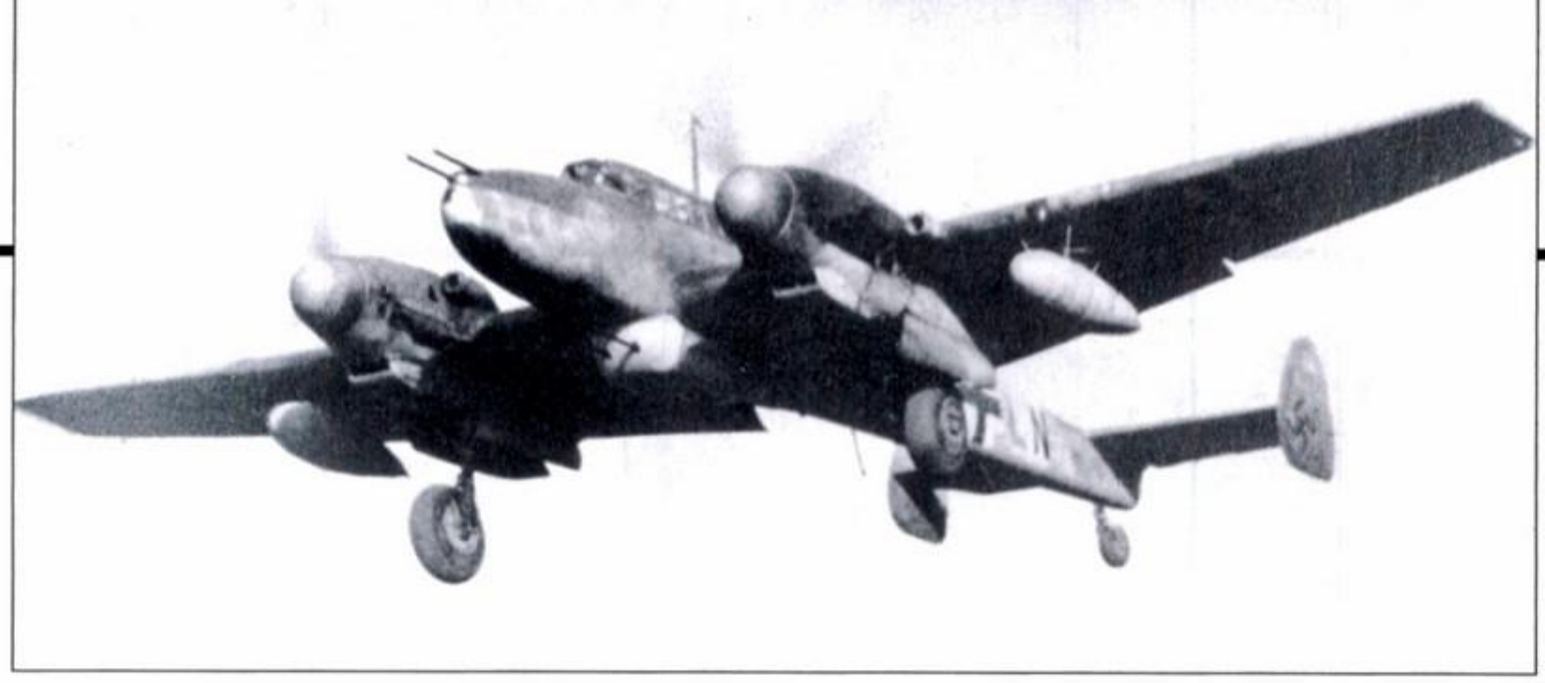
The Do 217 did, however, have one champion. As long ago as 1941, NJG 1's Rudolf Schönert had proposed that a vertical, upward-firing machine-gun should be mounted in a Do 17, arguing that the average pilot would find it easier to engage an enemy bomber in level flight from below than he would by any other method of attack. Although Kammhuber rejected the idea at first, Schönert tried again the following year. This time, with the added weight of 21

Friedrich-Karl Müller: Wilde Sau *Experte*

The most successful of the Luftwaffe's single-seat night-fighter pilots, Friedrich-Karl Müller flew both Fw 190s and Bf 109s with the Geschwaderstab JG 300 during its initial operations as a Wilde Sau unit. Among these aircraft was this Fw 190A-6, based at Bonn-Hangelar in November 1943, displaying 16 of the then-Hauptmann Müller's kills, three of which were claimed over Berlin on the night of 23/24 August 1943. He went on to command 1./NJGr 10 before joining I./NJG 11.

By the end of the war, the Wilde Sau units were busy round-the-clock, as evidenced by the day fighter camouflage on this Bf 109G-14 flown by Major Friedrich-Karl Müller, Gruppenkommandeur of I./NJG 11 at Werneuchen in late 1944. Müller had 30 victories to his name by war's end, all but seven achieved on Wilde Sau sorties.





The Luftwaffe's night-fighter force was not confined to the Western Front. This heavily-loaded Bf 110 of 5./NJG 200 (coded '8V+LN') lands at an unknown airfield in the east. Devoid of radar, the aircraft carries twin nose-mounted MK 108 30-mm cannon and a pair of MG 151/20s in a tray under the fuselage.

victories and the Knight's Cross (awarded on 25 July 1942) to his name, Oberleutnant Schönert was given a hearing.

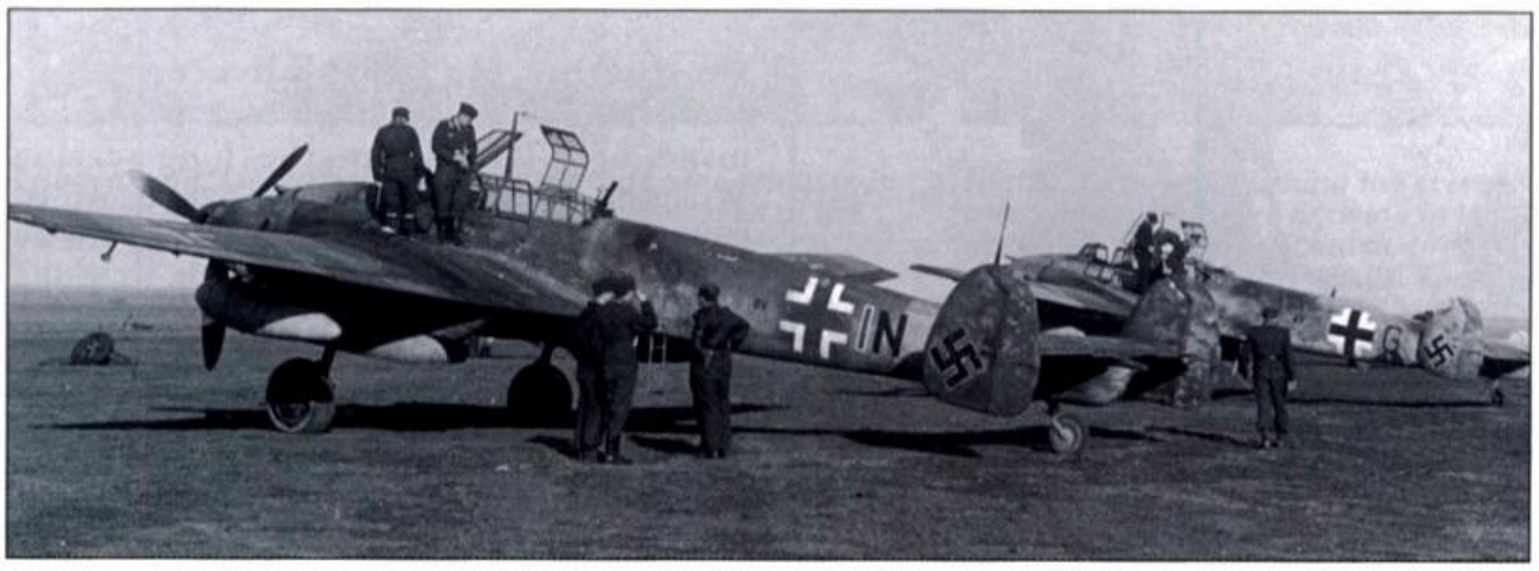
The outcome was that three Do 217s equipped with oblique, upward-firing MG 151 cannon were delivered to Schönert's Staffel early in 1943 for operational trials. (Initial tests had shown that weapons angled obliquely – at approximately 65-70° – were more effective than when completely vertical; the latter arrangement necessitated attacker and target to be on precisely the same course to guarantee success.) By this time, Schönert had been promoted to the command of II./NJG 5 at Parchim, but he had taken his own 'special' Do 217 with him, a machine he had fitted with upward-firing armament. Although Schönert regarded this as 'his' invention, there is still discussion as to who first introduced such an installation – legitimate claimants date back as far as World War I.

It was at Parchim that one of II./NJG 5's armourers, Oberfeldwebel Mahle, took a closer look at Schönert's 'special' Do 217. The Gruppe was currently in the process of up-gunning its Bf 110s, replacing their MG FF cannon with MG 151s. Mahle was of the opinion that a pair of the redundant MG FFs could be installed to fire upwards through the canopy of a Bf 110. In a Bf 110 thus modified by Oberfeldwebel Mahle, Hauptmann Schönert reportedly scored the Luftwaffe's first kill with upward-firing armament, over Berlin in May 1943. Similar victories followed in short order, including several claimed by the trials Do 217s of Schönert's old Staffel.

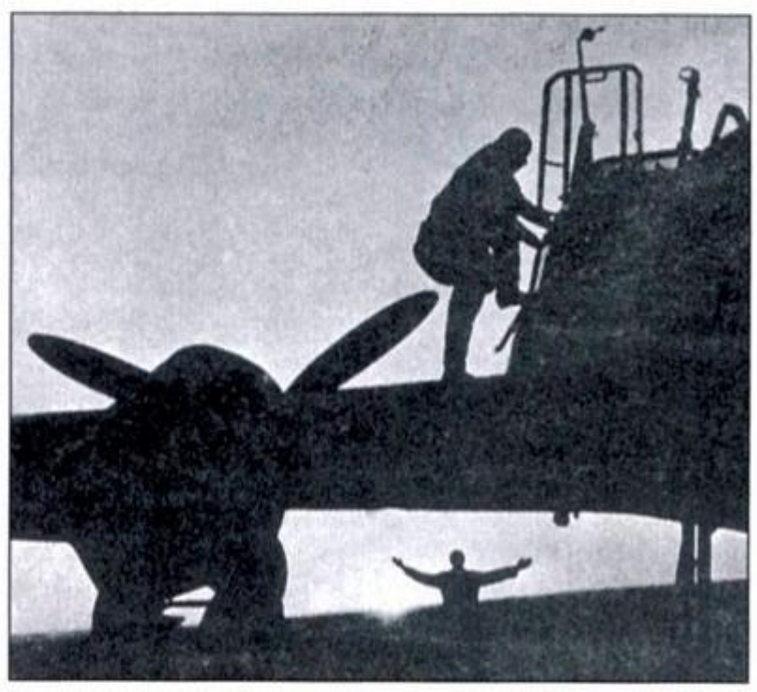
Official acceptance was rapid. Within a

Above left: In this photograph taken in the Crimea during spring 1943, Oberfeldwebel Josef Kociok uses his 'victory stick' to point to his current score: 20 enemy aircraft destroyed, including eight by night. A member of 10./ZG 1 (also known as 10.(NJ)/ZG 1), Kociok received a Knight's Cross (for 27 kills) on 31 July, but was killed on 26 September over the Kerch Peninsula when his aircraft collided with a crashing Soviet machine. His final score was 33 – 21 by night.

Above: Hauptmann Prinz Heinrich zu Sayn-Wittgenstein, Gruppenkommandeur of IV./NJG 5, is pictured here with his Ju 88 on the Eastern Front in the summer of 1943. Of the 29 kill bars on the tail, 24 are for RAF aircraft, the remaining five for Soviet machines. 'Linked' bars are believed to indicate multiple kills on the same night.



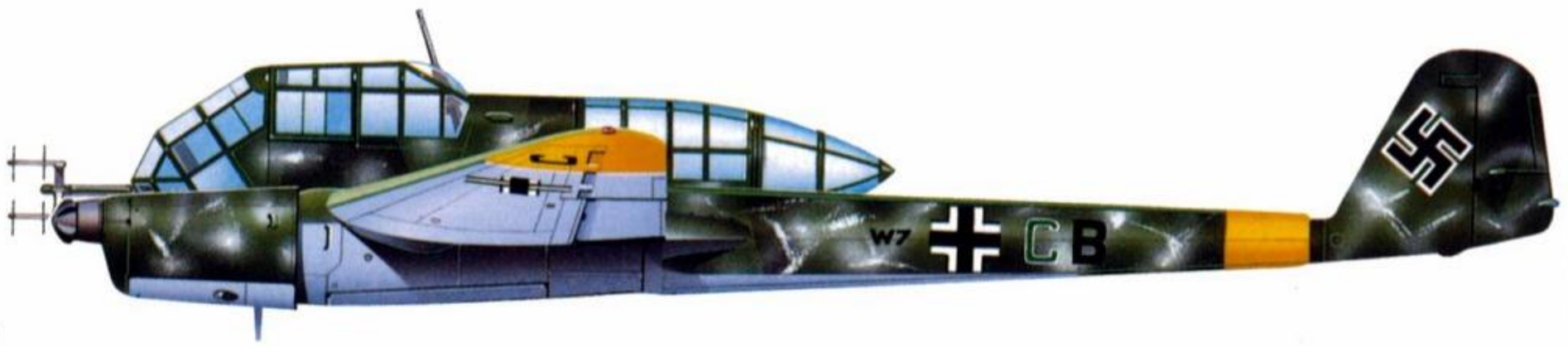
Below: A pair of 5./NJG 200's Bf 110s is seen here, parked at an airstrip on the flat, featureless steppe of southern Russia.

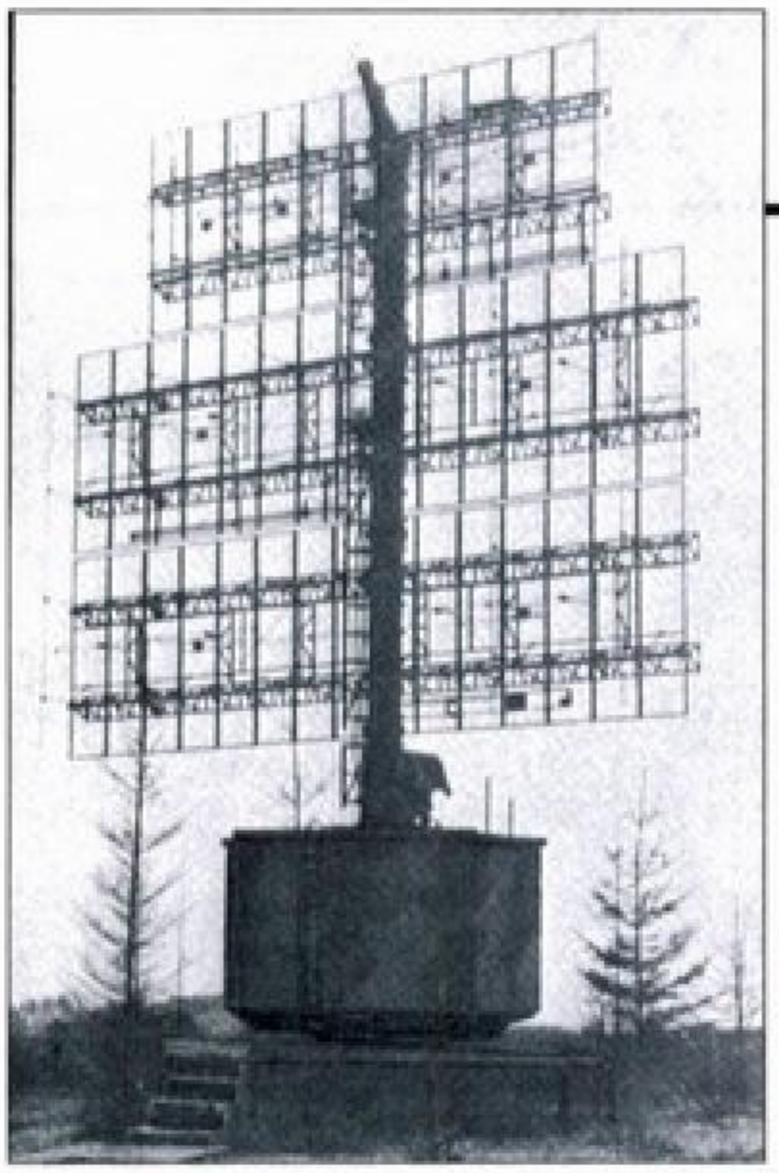


Right: "Somewhere in Russia", a pilot climbs into his Bf 110 as the setting sun heralds the start of another night's hunting.

Eastern Front conversion

Operating in an interim night-fighter role, this modified Fw 189A-1 (one of at least 30 conversions) flew with Stab./NJG 100 in February 1945, tasked with defending German rail targets against Soviet Polikarpov Po-2 nuisance raiders. Note the nose-mounted FuG 212 radar set and MG 151/15 or /20 cannon in a *schräge Musik* installation.





GOC XII. Fliegerkorps from September 1943, Generalmajor Josef 'Beppo' Schmid (third from left) replaced the beleaguered Generalleutnant Josef Kammhuber, whose star faded in the face of a failing Himmelbett system, and a mixture of personal animosity and professional jealousy among his colleagues.

Far left: Seen here is an improved Freya (FuMG 401A or Freya-LZ), of which over 300 units were built. FuMG 401A used two spot frequencies to counter Window and, if necessary, could be dismantled for transportation.

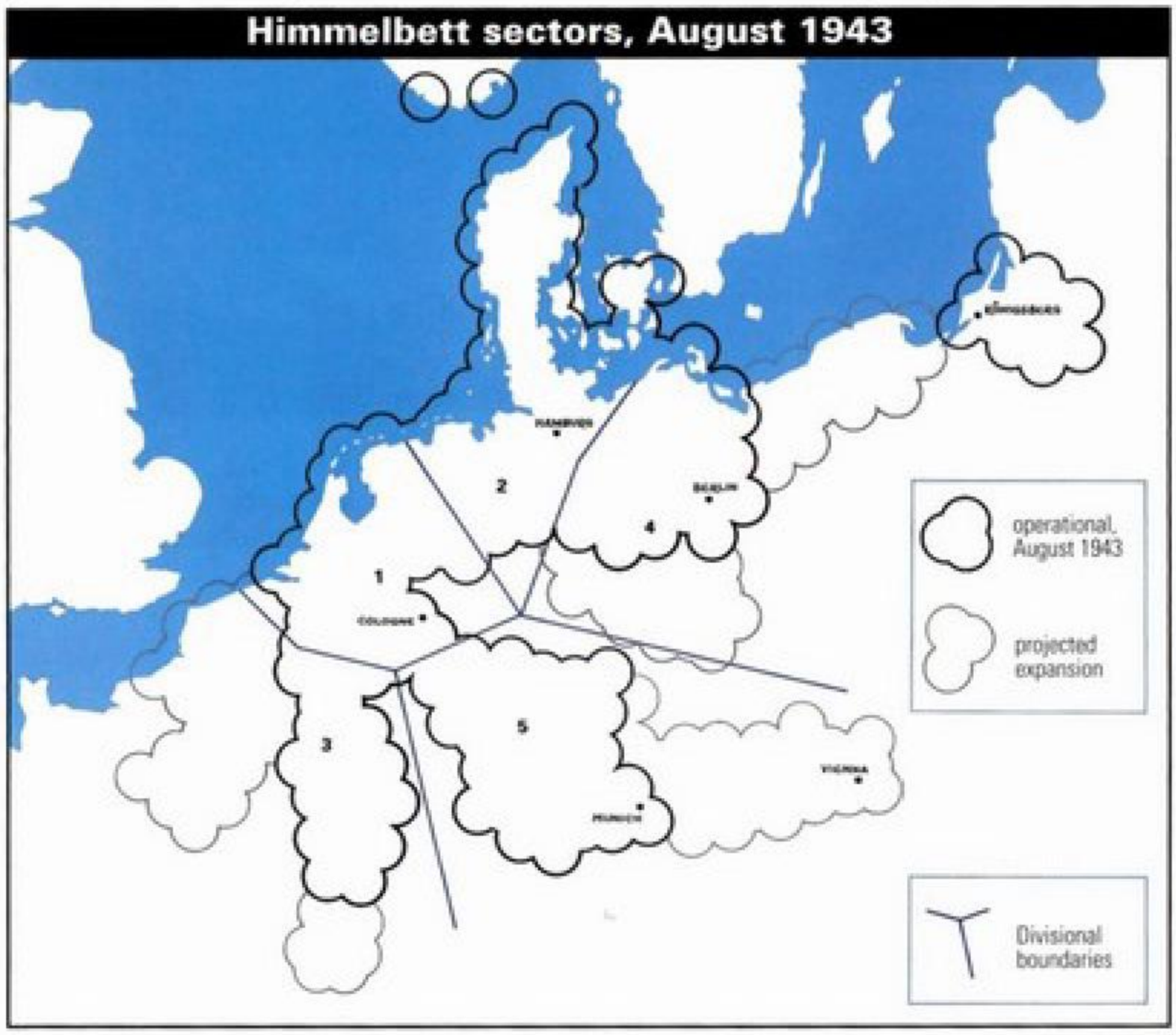
month, special Rüstsätze (modification kits) were in production to provide both the Do 217 and the Ju 88 with upward-firing armament. Strangely, no such pack was produced for the Bf 110 at first, and a number of 'unofficial' Mahle-inspired modifications were successfully installed and operated before the Messerschmitt Gruppen were issued with their own kits.

Upward-firing guns quickly found favour with night-fighter aircrews, irrespective of the type of aircraft they were flying. The Luftwaffe called these installations *schräge Musik* (literally, 'oblique music', i.e., jazz). As *schräge Musik* did not fire tracer rounds, its existence remained undetected and unsuspected by the RAF for a good six months, during which time scores of bombers were brought down without their crews knowing what had hit them.

Aware of his pilots' general dislike of the Do 217, Kammhuber pinned his hopes on another aircraft entirely. The Heinkel He 219 was no converted bomber, but had been designed specifically as a night-fighter from the outset. Kammhuber had been pushing hard for its development and had succeeded in having several pre-production models transferred to I./NJG 1 at Venlo for operational evaluation.

On the night of 11/12 June 1943, Gruppenkommandeur Major Werner Streib, who was already familiar with the aircraft after participating in earlier factory trials, took the He 219 on its first operational flight. During the course of this sortie he claimed the destruction of no fewer than five RAF bombers! Although he wrote the machine off when landing back at Venlo – with his flaps inoperative, Streib ran out of runway while still travelling at high speed – the future of the He 219 seemed assured, particularly when the remaining aircraft quickly racked up another 20 kills, six of which were Mosquitos, a type hitherto considered nearly invulnerable to interception.

In addition to the usual production and powerplant problems which plagued nearly every new German aircraft design, the He 219 also had to contend with other facts of life inherent in the Luftwaffe hierarchy: personal animosities and professional jealousies. The official reason for Generalluftzeugmeister Erhard Milch's antagonism towards the He 219 was that it was too specialised a design, unable to fulfil any other role, but the antipathy between Milch and both Heinkel and Kammhuber was common knowledge. Other manufacturers played on it. Junkers, for one, lost no opportunity to denigrate the He 219's every perceived fault, anxious to promote his own night-fighter projects.



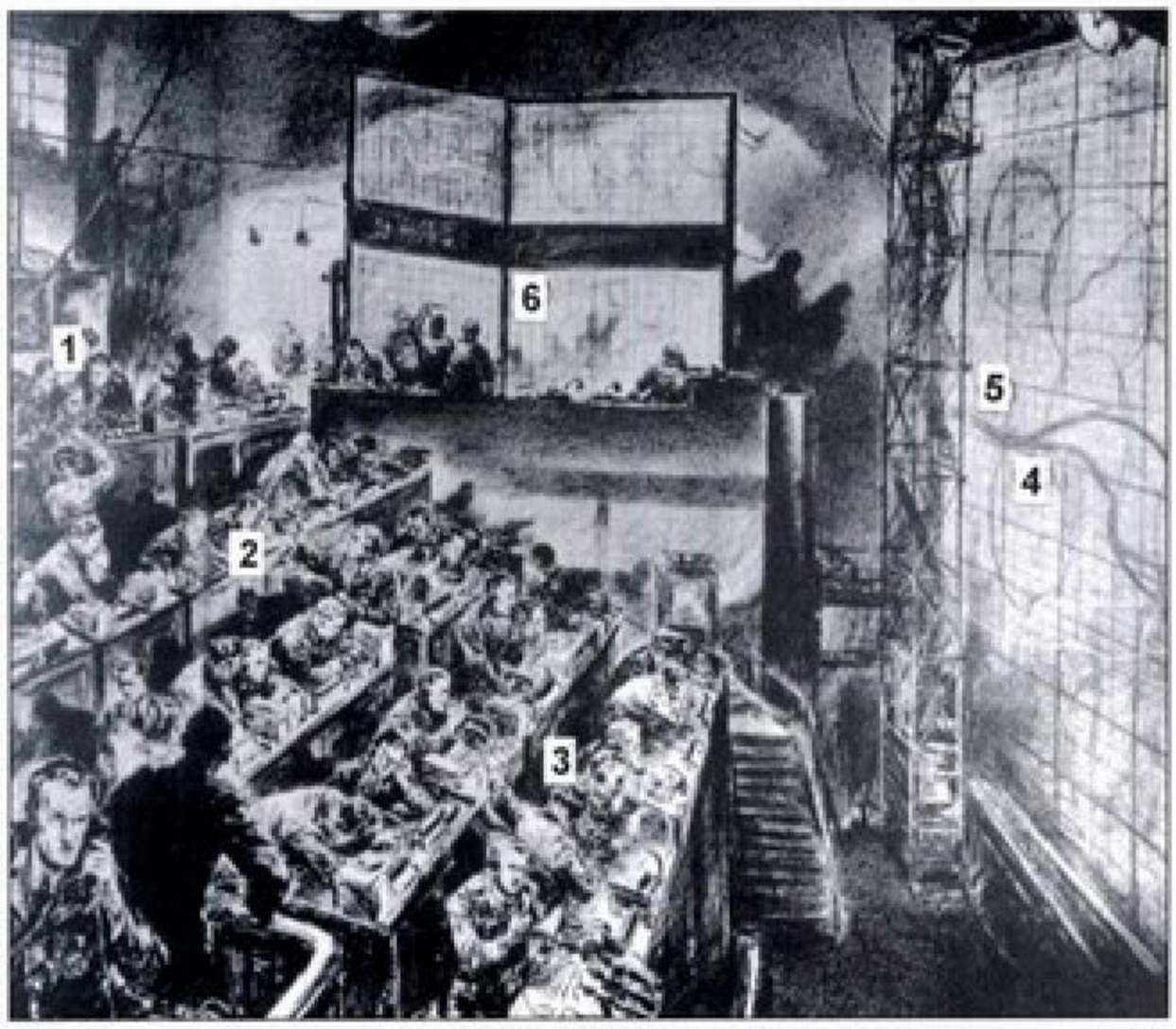
Of the Himmelbett sectors operational in August 1943, Königsberg and Munich were primarily training areas. The projected expansion of the system was abandoned after it was compromised by Window in July/August 1943.

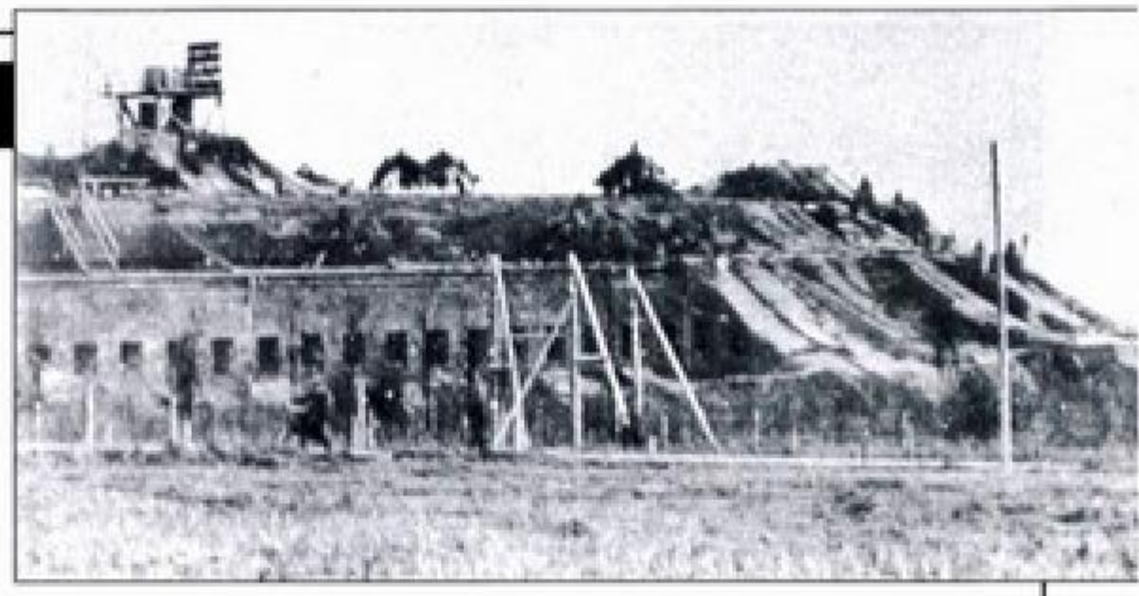
Production He 219s delivered

On 1 July Werner Streib took over command of NJG 1 from the long-serving Wolfgang Falck, but nearly six months passed before the first few production He 219s were delivered to his old Gruppe. Such were the delays and difficulties faced by – and placed in the path of – this potentially superior night-fighter that I./NJG 1 remained the only unit to be equipped with the He 219 in appreciable numbers. Its qualities were beyond doubt. Several NJG 1 pilots gained multiple victories in a single mission, 3. Staffel's Oberfeldwebel Wilhelm Morlock claiming six kills, and one probable, in the space of just 12 minutes on one memorable occasion. On the other hand, it must be admitted that three of I./NJG 1's four subsequent Gruppenkommandeure lost their lives while flying the He 219, two in mid-air collisions and the third in a landing accident.

Despite, or perhaps because of, his championing the He 219, Kammhuber's star continued to wane. On 27 June 1943 Major Hajo Herrmann, an experienced Ju 88 bomber pilot serving on the Luftwaffe Operations Staff, once more placed before Göring his plans for the establishment of a single-engined night-

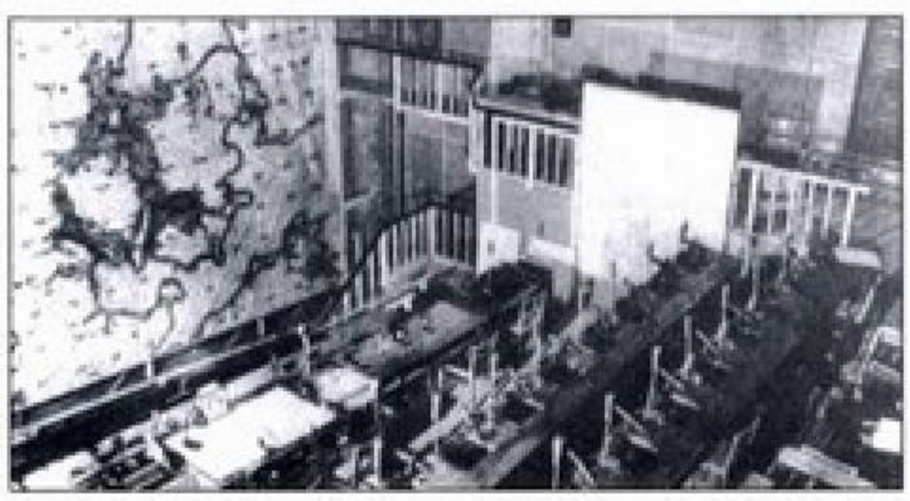
'Kammhuber-Kinos'





Day and night operations were controlled at Jagddivision (Fighter Division) level in huge concrete bunkers such as this (above). 'Sokrates' was HQ of 2. Jagddivision at Stade in northern Germany. These establishments were christened 'Battle Opera Houses' by Galland, General of Day Fighters, but known to night-fighter crews as 'Kammhuber-Kinos' (Kammhuber's Cinemas'), both names referring to their interior layout.

Left: Though each HQ differed slightly, this sketch shows a typical 'Kammhuber-Kinos' interior, with personnel positioned as follows: ① Division commander (when present) with the Jägerleitoffizier (main fighter controller) and representatives of other arms (flak, searchlight, army, navy, etc.); ② Fighter controllers in direct radio contact with night-fighters in the air, reporting progress of the enemy and vectoring fighters towards them; ③ Plotters (usually Luftwaffehelferinnen) using light projectors indicated positions of hostile and own forces on a large, glass map screen ④ divided into sectors and a grid and showing the path of the enemy force ⑤; ⑥ Smaller side screens showed the situation in adjacent divisions.



Above right: Luftwaffehelferinnen plotters are seen here in position at their consoles, facing a gridded screen of the North Sea.

Above: From information received from outlying radar stations, each plotter aimed her light projector at the map (red dots indicated enemy bombers, blue dots Luftwaffe fighters). The map screen displayed a running update of the current situation, with a minimal time lag.

Right: Meanwhile, behind the screen, other personnel were drawing in the developing situation (course, times, etc.) with chinagraph pencils. Taught to use mirror-writing, these 'behind the scenes' workers kept the situation up-to-date and provided an easy-to-read overview of developments.

fighter force independent of Himmelbett or any other form of ground control. Patrolling the target areas, these fighters, using purely visual means, could attack bombers caught in searchlight beams or silhouetted against the ground fires below. Herrmann had already advocated such a scheme in the spring, but it had been turned down. This time he was more persuasive. There would be no need, he argued, for additional aircraft. Every new unit could be 'twinned' with an existing day-fighter Gruppe, whose machines would be taken over and used during the hours of darkness. Nor did the provision of pilots pose a problem. There were plenty of night-flying instructors, together with ex-bomber and -transport pilots qualified in blind-flying, currently sitting behind desks, who would jump at the opportunity of returning to operational flying.

Smitten by the economics of the project, and beguiled by the vision of dozens of bombers going down in flames around the town or city under attack, Göring gave his blessing. He ordered that Herrmann's small experimental Kommando at Bonn-Hangelar be used to form the nucleus of a brand new Geschwader, JG 300, with Stab and I. Gruppe at Bonn, II. Gruppe at Rheine and III. Gruppe at Oldenburg.

Wilde Sau tested

Within a week, Herrmann's theory had been put to the test. On the night of 3/4 July, on its first 'massed' sortie, the small Bonn Kommando of single-seaters got in among a force of over 650 RAF bombers attacking nearby Cologne. Seventeen interceptions were made, resulting in claims for 12 enemy aircraft destroyed.

Herrmann had gone over Kammhuber's head in first presenting his ideas to Göring. Now he set about organising his Geschwader and perfecting its 'new' night-fighting technique, which was soon officially codenamed Wilde Sau (Wild Boar). Kammhuber kept his counsel about this sudden and unasked-for addition to the Reich's established night-fighter defences, but privately he regarded Herrmann's unit as little more than a temporary expedient to be used in times of emergency while he continued methodically to expand his Himmelbett cover-age of the approach routes to every important target. What Kammhuber did not know was that the Himmelbett chain – the very bedrock of his whole defensive system – was about to come crashing down around his ears.

The night of 24/25 July 1943 witnessed the first of four major attacks by Bomber Command on the port city of Hamburg. It was the second raid of this brief but concentrated series, mounted 72 hours after the first, which

Above: Delays caused to the He 219 programme by Allied bombing brought about the requirement for a second new night-fighter design, to be constructed largely of wood. Such a design would not only help ease the demand on Germany's metal reserves, but was a way of utilising the skills of trained wood-workers. The first prototype made its maiden flight on 1 July 1943. The third Moskito, seen here, was the first to be fitted with a radar (an early FuG 202 or 212 set) becoming the Ta 154A-0/U1 prototype for the first production variant, the Ta 154A-1.

The last of eight pre-production Ta 154A-0s, Ta 154 V15, is seen here equipped with FuG 220. The Moskito entered service in the last months of the war, though in very limited numbers. 3./NJGr 10 received several examples for service evaluation, while I./NJG 3 at Stade received a handful in late 1944, their first operational sortie taking place on 19 November. A further batch of three aircraft was delivered to the unit in early 1945. A Junkers document dated 16 March states that Ta 154s allocated to III./NJG 3 were repeatedly scrambled to intercept RAF Mosquitos, without success, while a 2nd TAF, RAF document positively identifies a crashed Ta 154A-4, carrying the codes of III./NJG 3. Some sources also suggest that NJG 2 may have operated a number of Ta 154s, but without radar.

resulted in a horrendous firestorm and caused so many thousands of civilian casualties.

Human suffering aside, the Hamburg raids delivered a crippling and totally unexpected blow to the Nachtjagdwaffe. The RAF had unleashed its latest secret weapon in the radar war: a strip of aluminium foil some 30 cm (12 in) long and 15 mm (⅝ in) wide. British and German scientists had both been conducting tests with the idea of using metallic or metallised strips against the enemy's radar, and both had arrived at the same conclusion: if released into the air in sufficient quantities, such strips could effectively neutralise radar detection.

Each side kept the discovery a closely guarded secret. The Germans were horrified at the realisation that their entire defence network could, at a stroke, be rendered ineffectual by such a simple item as an aluminised paper strip (which they christened Düppel, chaff). The British, for their part, did not want to reveal the existence of their aluminium foil strips (codenamed Window) prematurely, but stayed their hand until the time was right.

That time came on the night of 24/25 July. Between them, the attacking force of over 700 bombers released some 46,000 bundles of Window as they approached Hamburg – each bundle consisted of 2,000 individual strips, some 92 million in all. The result was chaos. German ground and airborne radars, working on similar frequencies, were swamped by clouds of metal strips drifting slowly earthwards; flak batteries and night-fighters alike were blinded. Just 12 bombers were destroyed, and night-fighters stumbled across nine of them. It is estimated that the anti-aircraft guns expended some 50,000 rounds to bring down the other three.

Cologne had been just a turning point. Hamburg was the real beginning of the end.

While Kammhuber had been painstakingly assembling the Homeland's nocturnal defences, a very different kind of night-fighter war was being fought in the Soviet Union. Like the deployments to the Mediterranean mentioned in passing above, night-fighter activity on the Eastern Front was not an integral part of Defence of the Reich operations (except towards the very end, when a small Bf 110 presence was stationed in northern Italy and when the remnants of the Eastern Front units had been pushed back to German soil). The unique nature of the night air war against the Soviets, and the diverse types of aircraft employed by the units involved in that war, do merit brief mention.

The most obvious difference between British and Soviet night bombing policies was that the latter dispatched no huge streams of strategic heavy bombers, many hundreds strong, to attack the Reich's eastern industrial areas. Much of the Red Air Force's effort was on a tactical level, carried out in the immediate vicinity of the front lines by medium bombers. There were other activities, too: nocturnal supply flights to bands of partisans in the rear of the advancing Germans, and night harassment raids by light aircraft, individually or in small groups, over the invader's trenches and along the lines of supply.

These harassment tactics had begun almost from the moment Operation Barbarossa, Germany's attack on the Soviet Union, had been launched. In response to them, the first Luftwaffe night-fighter sorties of the Eastern Front were flown. They were mounted on a purely individual basis by personnel of day units in the areas where such nuisance raids were made.

Success against the Soviets

Later, a number of Luftwaffe day pilots achieved considerable success against the Soviets by night. In the summer of 1942 the Bf 109s of JG 54 – the famous 'Green Hearts' – claimed 56 nocturnal kills over the Volkhov sector; Leutnant Erwin Leykauf was credited with six on the night of 23/24 June alone. To the south, in the area of Stalingrad, Unteroffizier Paul Döring of the He 111-equipped KG 55 shot down three Tupolev TB-3 bomber-transports. The top scorer was probably Oberfeldwebel Josef Kociok, a Zerstörer pilot with ZG 1: 21 of his 33 Eastern Front victories were achieved during the hours of darkness.

Commendable as these personal scores were, they were but a drop in the ocean. The next step in the escalation of the night air war in the east was an order sent to all local commands instructing them to set up night-fighter Schwärme (formations of four aircraft) drawn from their existing establishments. The result was a motley collection of single- and twin-engined machines deployed in penny-packet numbers at scattered points along the length of the 2000-km (1,243-mile) front ('penny-packet'

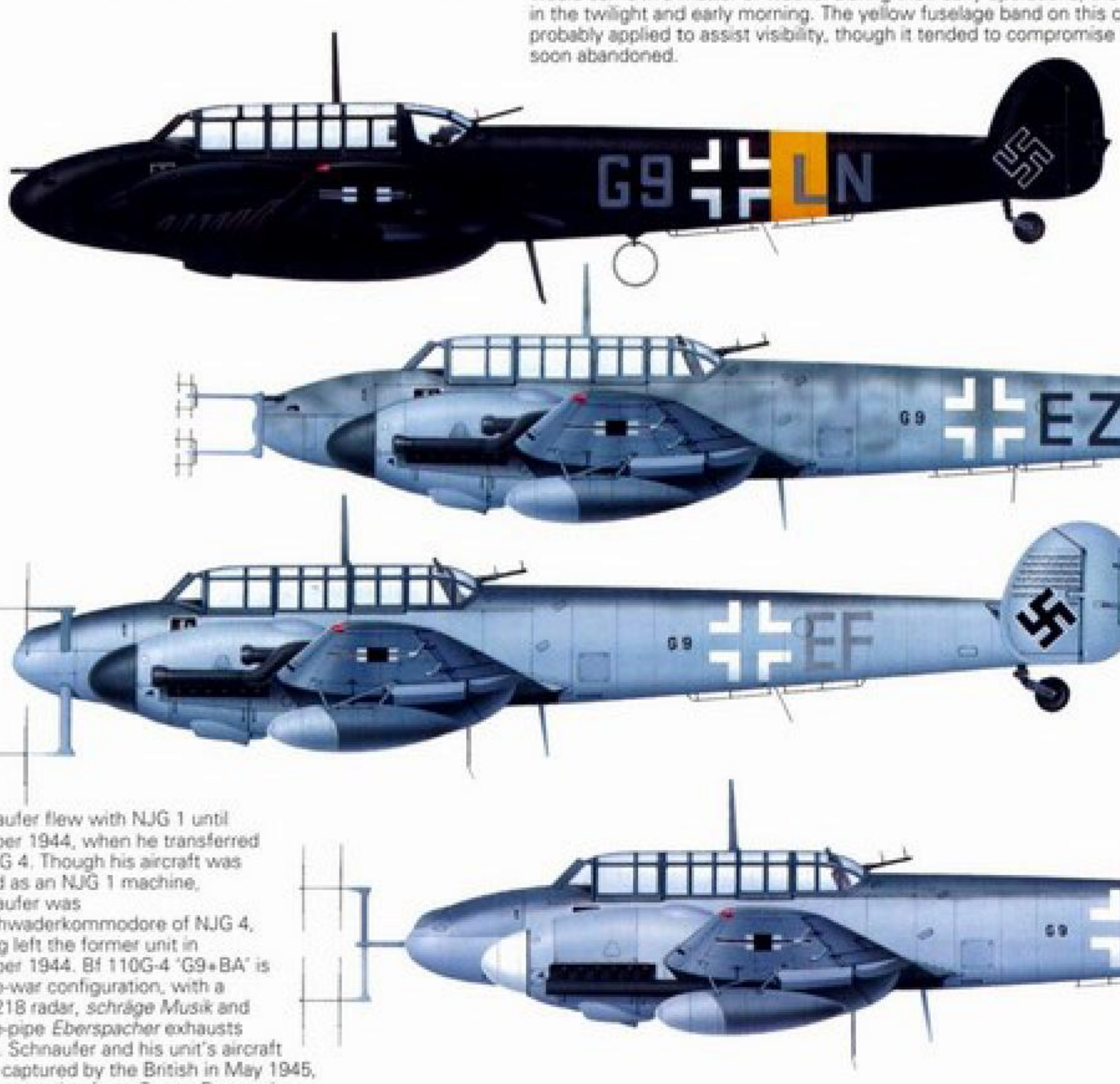
Night-fighter aces with 50+ nocturnal victories

	Total	NJG(s)	Awards	Fate
SCHNAUFER, Maj. Heinz-Wolfgang	121	1,4	KC,OL,S,D	S
LENT, Oberst Helmut	102 (8)	1,2,3	KC,OL,S,D	DW 7 October 1944
Prinz zu SAYN-WITTGENSTEIN, Maj. Heinrich	83	2,3,5,100	KC,OL,S	KiA 21 January 1944
STREIB, Oberst Werner	65 (1)	1	KC,OL,S	S
MEURER, Hptm. Manfred	65	1,5	KC,OL	KiA 21 January 1944
RÖKKER, Hptm. Heinz	64 (1)	2	KC,OL	S
RADUSCH, Oberst Günther	64	1,2,3,5	KC,OL	S
ÖNERT, Maj. Rudolf	64	1,2,5,100	KC,OL	S
ZORNER, Maj. Paul	59	2,3,5,100	KC,OL	S
BECKER, Hptm. Martin	58	3,4,6	KC,OL	S
RAHT, Hptm. Gerhard	58	2,3	KC,OL	S
HERGET, Maj. Wilhelm	57 (15)	1,3,4	KC,OL	S
FRANCSI, Oblt. Gustav	56	100	KC	S
KRAFT, Hptm. Josef	56	1,4,5,6	KC,OL	S
STRÜNING, Hptm. Heinz	56	1,2	KC,OL	KiA 24 December 1944
FRANK, Hptm. Hans-Dieter	55	1	KC,OL	KiA 27 September 1943
VINKE, Ofw. Heinz	54	1	KC,OL	KiA 26 February 1944
GEIGER, Hptm. August	53	1	KC,OL	KiA 29 September 1943
LUTJE, Otl. Herbert	53	1,6	KC,OL	S
HOFFMANN, Maj. Werner	51 (1)	3,5	KC	S
Prinz zur LIPPE-WEISSENFELD, Maj. Egmont	51	1,5	KC,OL	KAS 12 March 1944
WELTER, Oblt. Kurt	50+ (5)	11	KC,OL	S

Key: KC = Knight's Cross; OL = Oak Leaves; S = Swords; D = Diamonds; KiA = Killed in Action; KAS = Killed on Active Service; DW = Died of Wounds; S = Survived war; ( ) = additional day victories

Schnaufer's Bf 110s

In the summer of 1942, Bf 110C 'G9+LN' was the mount of Oberleutnant Heinz-Wolfgang Schnaufer, then of 5./NJG 1 at St Trond, Belgium. He had yet to score his first kill, though this would come in a matter of weeks. During their early operations, the Nachtjagd tended to operate in the twilight and early morning. The yellow fuselage band on this otherwise black aircraft was probably applied to assist visibility, though it tended to compromise the night camouflage and was soon abandoned.



Equipped with FuG 202 and *schräge Musik*, Bf 110G-4 'G9+EZ' was flown by Schnaufer while Staffelkapitän of 12./NJG 1 at St Trond in February 1944. His 47 kills up to that scored on the night of 14 June are marked on the aircraft's tail fin.

By March 1944, Schnaufer had been promoted to Major and was Gruppenkommandeur of IV./NJG 1, a position he held until October. During this period he scored his 100th victory. Bf 110G 'G9+EF' has FuG 220 and *schräge Musik* installed.

Schnaufer flew with NJG 1 until October 1944, when he transferred to NJG 4. Though his aircraft was coded as an NJG 1 machine, Schnaufer was Geschwaderkommodore of NJG 4, having left the former unit in October 1944. Bf 110G-4 'G9+BA' is in late-war configuration, with a FuG 218 radar, *schräge Musik* and single-pipe *Eberspacher* exhausts fitted. Schnaufer and his unit's aircraft were captured by the British in May 1945, while operating from Grove, Denmark.

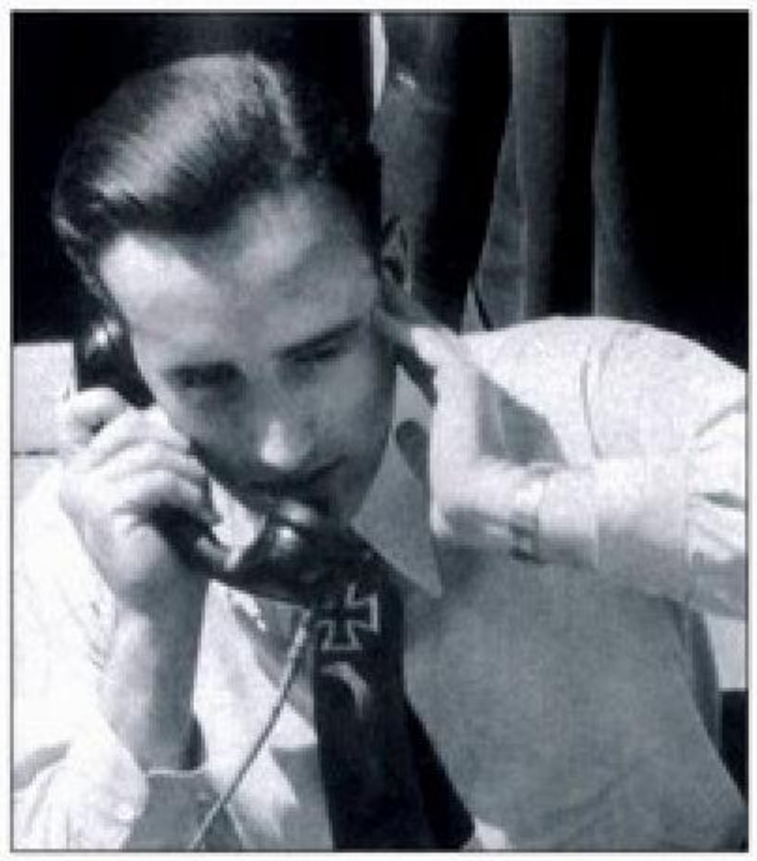
is perhaps too strong an expression – in February 1943 the entire 'auxiliary' night-fighter strength on the Eastern Front reportedly totalled exactly eight machines).

It was not until things were put on an official footing with the transfer eastwards of a hitherto Reich-based Nachtjagdgruppe that matters began to improve. The unit selected for deployment to Russia was Hauptmann Heinrich Prinz zu Sayn-Wittgenstein's IV./NJG 5, detachments from which had already served briefly along the Baltic coast. At the end of June 1943 IV./NJG 5 arrived at the central sector of the Eastern Front. It did not stay there long as, uniquely, the Gruppe was about to become fully mobile. It was split into its three component Staffeln, each of which was then further sub-divided into three separate Schwärme. The nine small Kommandos thus formed were each assigned a fully self-contained railway train, complete with living quarters, stores, workshops and everything else necessary to allow them to operate with complete independence. Five of the nine even had the benefit of accompanying, rail-mounted Würzburg radars to provide local ground control.

The effects were soon apparent. In its first month in the east, spent supporting the Kursk offensive, the Gruppe claimed 49 victories. Seven fell to the Kommandeur himself during one hectic 24-hour period. On 1 August 1943 IV./NJG 5 was redesignated I./NJG 100. Four days later 'Henry' Wittgenstein returned to the Reich to assume command of II./NJG 3 and his place at the head of I./NJG 100 was taken by Hauptmann Rudolf Schönert, of *schräge Musik* fame. The German reversal at Kursk set in motion the general retreat from the east which would only be halted when the Red Army was in the centre of Berlin. For the next three months, however, the Schwärme of I./NJG 100 continued to fly and fight from bases and airfields alongside the major railway lines that traversed the central and southern sectors of the Russian front.

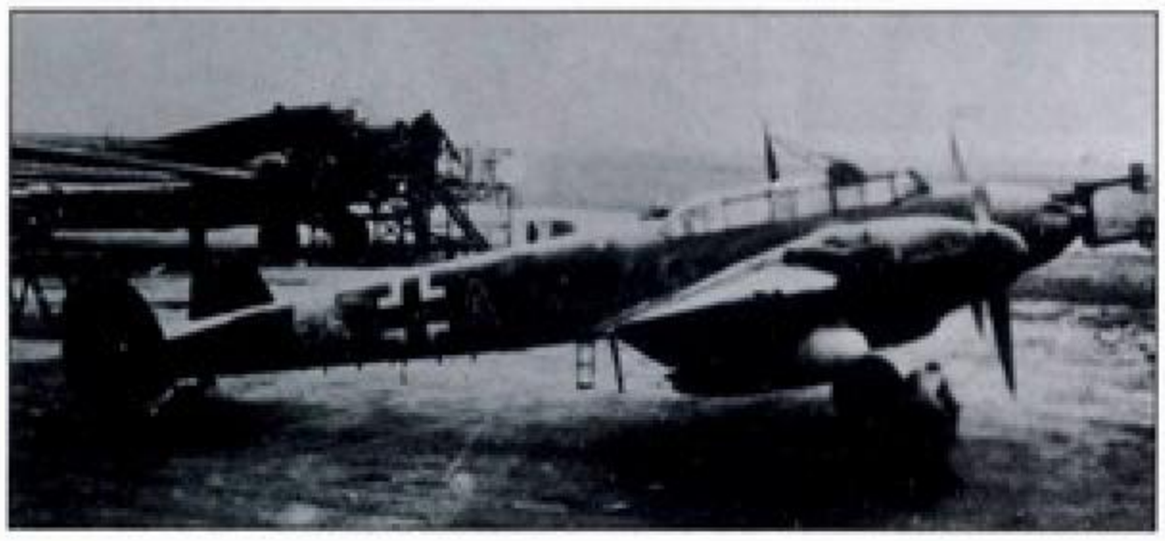
During this period their success rate began to fall. Although some pilots continued to add to their list of kills (the Gruppe's – and the Eastern Front's – highest scorer was Oberleutnant Gustav Francsi, who ended the war with a total of 56 victories), the majority found conditions very difficult. Ground radar control, whether fixed or mobile, did not offer the advantages it provided in the west. Small, low-flying biplanes

Hauptmann Heinz-Wolfgang Schnaufer, Gruppenkommandeur of IV./NJG 1, is seen here in the summer of 1944. By this time he was the second-highest scorer of the Nachtjagdwaffe. He received the Oak Leaves on 24 June, having scored his 84th kill.



Luftwaffe Nachtflieger

Right: Bf 110s are seen at an unknown airfield during daytime servicing. Despite the adverse effects of Window on its performance, FuG 212 continued in use until the end of the war.



Left: The first Lichtenstein radar sets and their associated arrays cut around 25 mph (40 km/h) from the Bf 110's intercept speed. This Bf 110G carries such a set – probably FuG 202. The larger array of the later FuG 220 produced even more drag, though neither array had as dire an effect on performance as had been predicted.

Right: This Bf 110G-4, probably from NJG 4, carries a pair of ETC bomb racks in place of the normal underwing drop tanks – evidence that it has been engaged in night ground attack missions. These began after the Normandy landings and continued through 1944, using inexperienced crews only recently released from the ill-fated daylight interception sorties.

were not easy to detect and, if they were located and engaged, they were not easy to bring down. The Gruppe's Ju 88s and Bf 110s were simply too fast to play the sort of cat and mouse games in which the Soviets indulged. Pilots took to lowering flaps and undercarriages in order not to overshoot their intended victim (a ploy denied anyone unfortunate enough to be flying one of the unit's few Do 217s, which would simply fall out of the sky at such low speeds).

In an effort to meet the Red Air Force on more equal terms, a number of other aircraft types were called into service. Hauptmann Schönert managed to get hold of a Ju 87 Stuka, in which – true to his faith – he intended to install upward-firing armament (although whether he ever actually managed to do so is not recorded). One machine which did lend itself to the installation of *schräge Musik*, and a nose-mounted radar array, was the twin-boom Fw 189. Fitted with additional armament and other excrescences, several such Focke-Wulfs were flown by pilots of the Gruppe and served them well, although, as one observed in a post-war interview, "We took the Luftwaffe's fastest reconnaissance aircraft and managed to turn it into its slowest night-fighter."

Undoubtedly the most successful second-line type drafted into the night-fighter arm was another Focke-Wulf design, the twin-engined Fw 58 Weihe light transport. It did have one serious drawback – its distinctive wing plan was very similar to that of the C-47/Li-2 transports used in large numbers by the Soviets and it was prone to attack by 'friendly' forces. When fitted with nose radar and *schräge Musik*, the 'Weihe' proved a very effective and economical answer to the Soviets' night harassment squadrons, and remained in service with I./NJG 100 until the end of the war. During the closing weeks, when Hauptmann August Fischer, the last Kommandeur of the Gruppe, landed one of these white-camouflaged 'Weihen' on a rear area airfield staffed mainly by female auxiliaries, one naïve young lady was heard to ask him, "Is this one of the new Wunderwaffen the Führer has been promising us?"

I./NJG 100's nomadic railborne existence came to an end in the spring of 1944 when the trains occupied by the individual Schwärme were returned to the companies of the Flugmeldedienst (Air Movements Reporting Service) which were their rightful owners. Despite the activation of a II. Gruppe in July 1944, successes had become few and far between. Still, the situation was not quite as bad as was painted by Oberstleutnant Werner Streib, by then promoted to Inspekteur der Nachtjäger, during a visit to the Gruppen that summer. "What am I to do with you lot?" Streib asked, only half-jokingly. "You Eastern Front night-fighters would be more use digging anti-tank ditches."

NJG 100's surrender

Ignoring this apparent lack of appreciation from on high, the pilots continued to do their best as the two Gruppen were pushed slowly back towards, and across, the Reich's eastern frontiers. The end of the war found the remnants of I./NJG 100 surrendering to British forces in the far north of Germany; those of II./NJG 100, scattered across Czechoslovakia and Austria, were being captured by the Soviets and Americans.

One other night-fighter unit operated exclusively on the Eastern Front, but NJG 200 was even less of a 'Geschwader' than NJG 100. The latter could at least boast two Gruppen, whereas NJG 200 consisted of nothing more than three separate Staffeln created out of the 'auxiliary' Schwärme originally set up by the local commands during the winter of 1942-43. The first to be activated – 1./NJG 200, whose strength during the latter half of 1943 rarely exceeded three serviceable Bf 110s – was employed on the central sector. 4. and 5./NJG 200, usually totalling some half-dozen Bf 110s and Ju 88s between them, were subordinated to Luftflotte 4 in the south.

The major difference between the two so-called Geschwader was that NJG 100 operated with the (sometimes dubious) benefit of ground radar control. The aircraft of NJG 200 flew purely visual *helle Nachtjagd* missions. Nevertheless, some success was achieved, primarily by 4. and 5. Staffeln over the Crimea and Black Sea areas. An attempt to establish three further Staffeln during the winter of 1943-44 was short-lived and the following summer NJG 200 was disbanded, its component units being used to form II./NJG 100.

Meanwhile, back in the Reich, Generalleutnant Kammhuber and almost the entire Nachtjagdwaffe establishment were still reeling from the aftershock of the 40 tons of aluminium foil dumped by Bomber Command during the attack on Hamburg on the night of 24/25 July 1943. A frantic search was immediately launched to find an antidote to the Window which had effectively blinded the entire Himmelbett system.

More immediate help was already to hand. Hajo Herrmann had, in truth, never intended

Nachtjagdkommando Norwegen was a mainly Ju 88G-6-equipped unit based at Gardemoen in 1945. At least four Bf 110Gs were also attached to the unit, including 'B4+KA', the mount of Feldwebel Kurt Keilig and his crew.

Above: The other side of the coin: Leeuwarden in the Netherlands witnesses the burial of an NJG 1 crew killed in action over Belgium on the night of 20/21 April 1944.

Right: Oberleutnant Leopold 'Poldi' Fellerer and his crew pose in front of their Bf 110 (with 22 kills on its tailfin) at Parchim, January 1944. Fellerer won the Knight's Cross on 8 April 1944, having downed 28 aircraft. His final tally stood at 41 aircraft, two of which were claimed by day. Note the wireless operator (left) who appears to be wearing a captured Allied flying jacket.

Right: Hauptmann Martin Drewes, Gruppenkommandeur of III./NJG 1, seen here at Leeuwarden in July 1944, survived the war with 52 kills (43 at night; nine by day, including seven four-engined bombers) and the Oak Leaves to his Knight's Cross.

his Wilde Sau proposal to be anything more than complementary to Kammhuber's existing defences. Now the roles were reversed. Despite having been dismissed by Kammhuber as "little more than a return to the old days of *helle Nachtjagd*", Herrmann's visual night-fighting force – in the shape of JG 300 currently working up – provided the best, and indeed only, method of combating the RAF during the hours of darkness.

Kammhuber's position was further eroded when another ex-bomber veteran, Oberst Viktor von Lossberg (who had previously been the Gruppenkommandeur of the pathfinding III./KG 26) suggested that the twin-engined Nachtjagdgruppen could also be employed in a modified form of Wilde Sau. Von Lossberg's plan was for Kammhuber's night-fighters to be directed towards the greatest concentration of Window interference (which, while masking the attacker's exact position, would indicate their approximate line of advance) by means of the Luftwaffe's 'Y'-system, a proven method of VHF navigational guidance. Once arrived in the general vicinity of the bomber stream, the night-fighters would then be free to begin a visual search. Ignoring Kammhuber's dire prophecies of the chaos that would ensue if two new forms of night-fighter operations were to be introduced in parallel to his present, albeit 'temporarily indisposed', Himmelbett system, von Lossberg's scheme was warmly welcomed and given the codename Zahme Sau (Tame Boar).

To help the single-seaters find their way around an otherwise blacked-out Germany – and to provide additional assistance to the twin-engine aircrews, who were more accustomed to operating on a tight rein from ground control

Experten of 1944

Oberleutnant Martin Drewes, Kommandeur of III./NJG 1 at Laon-Athies in France, flew this Bf 110G-4 decorated with his then-current 22 kills and his Knight's Cross. When he joined the Nachtjagd, Drewes had two Zerstörer kills and served exclusively with NJG 1. Note the SN-2b array, incorporating FuG 212 Lichtenstein C-1 Weitwinkel.

Based at Gütersloh in January 1944, Oberleutnant Leopold Fellerer flew this Bf 110G-4 while Gruppenkommandeur of II./NJG 5. Note the FuG 212 array; these early AI radars remained in service until the end of the war, despite the appearance of improved SN-2 sets.

It was not unusual for Bf 110 night-fighters to fly in camouflage such as this, more associated with Zerstörers. Note the Bf 110F-style tailfins on this Bf 110G-2, a standard feature on aircraft fitted with FuG 202. Its pilot was Hauptmann Rolf Leuchs, Gruppenkommandeur of II./NJG 6 at Echterdingen in March 1944, and a 10-kill *Experte* by war's end.

Above: One of the biggest threats faced by the Luftwaffe night-fighter force was that posed by the RAF's NF Mosquitos. Typical of these aircraft was this NF.Mk 30 of No. 85 Sqn, No. 100 Group, seen in late 1944, as it prepared to leave Swannington on another night intruder sortie. Mosquito units attached to No. 100 (Bomber Support) Group at this time were charged with protecting the RAF's heavy bombers from night-fighter attack and were equipped with equipment such as Serrate, a homing device which provided a bearing on FuG 202/212/220 Lichtenstein transmissions.

Left: The last moments of a II./NJG 1 Bf 110 as it falls to 20-mm cannon fire from a No. 85 Sqn Mosquito were recorded on the night of 4/5 November 1944. After the radar operator and gunner bailed out, the aircraft crashed into the Rhine at 21.50, killing pilot Oberleutnant Ernst Ranze.

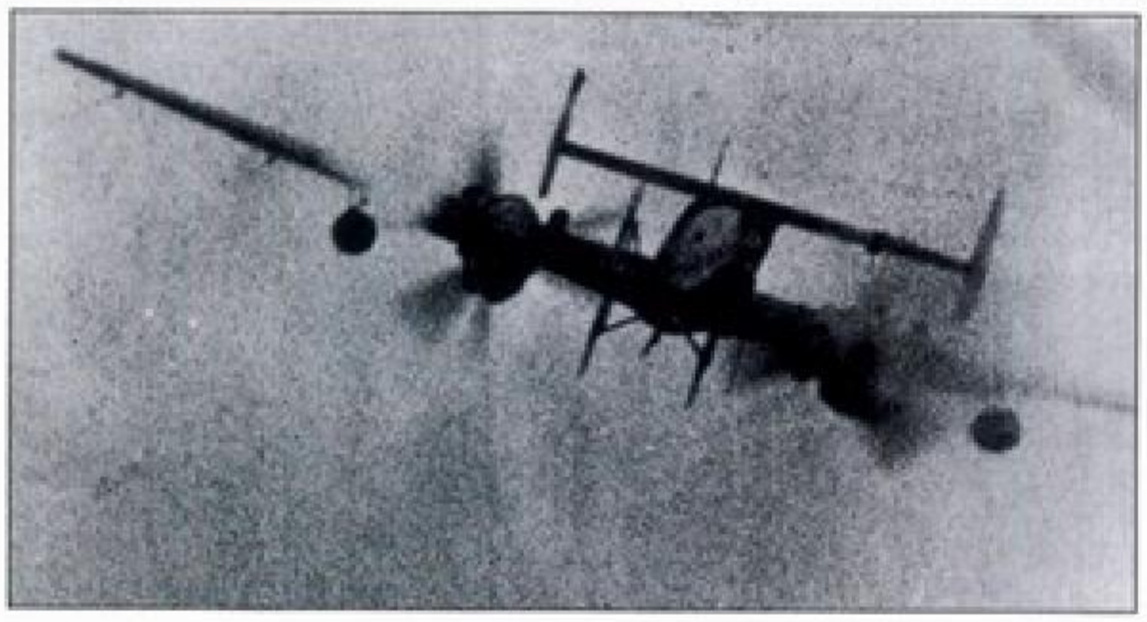
and remaining within the strict confines of their own particular Himmelbett box – a whole panoply of visual aids was quickly put in place. Searchlight lanes were set up between airfields close to important towns and conurbations. Ground radar beacons were supplemented by Sanduhr (Hourglass) sites, which comprised three or more searchlights with their beams angled to intersect at a fixed height. Major cities were identifiable by sets of searchlights arranged in specific geometrical patterns, backed up by local flak batteries firing starshells in pre-arranged colours and combinations.

While not attaining pre-Hamburg levels, night-fighter kills slowly began to climb again. Their proportions reflected the new tactics forced upon the Nachtjagdwaffe: of the 250 victories claimed in August, 202 were achieved during Wilde or Zahme Sau sorties, while only 48 were credited to Himmelbett operations.

All went well as long as the enemy continued to attack in single, solid streams. Bomber Command, though, began to mount 'diversions' – usually by small formations of Mosquitos – specifically designed to confuse the Luftwaffe's VHF ground controllers. One prime example of such occurred on the night of 17/18 August 1943. Convinced the target was to be Berlin, control vectored more and more fighters towards the capital. Alerted by the growing noise of engines over the city, flak defences opened up, which only served to convince the orbiting fighters that enemy bombers must be somewhere close. In fact, as confusion was heaped upon confusion above the capital, they were over 150 km (93 miles) to the north, attacking the V-2 rocket test centre at Peenemünde.

Six nights later, when the target truly was Berlin, the Nachtjagdwaffe turned the tables by inflicting the heaviest losses yet suffered by Bomber Command in a single night. Elements of six Geschwader found the bomber stream before it reached the capital and shot down 30 four-engined bombers in as many minutes. Altogether, the RAF's losses totalled 56. The most successful Luftwaffe pilot was Oberleutnant Friedrich-Karl Müller of Stab JG 300, who claimed three of that number.

Throughout this time Kammhuber had been striving to restore his shattered defences. Ironically, the late summer of 1943 was to witness a significant increase in his strength. At the end of July NJG 2's two Gruppen had returned from the Mediterranean and were joined by a new III. Gruppe. In August NJG 5 was brought back up to strength with the activation of a replacement IV. Gruppe to fill the gap left by the original IV./NJG 5's transfer to the Eastern Front. August also brought the beginnings of an entirely new Geschwader: NJG 6.



Left: Captain Raymond 'Bud' Care of the 334th FS/4th FG destroyed this Bf 110G-4 on 11 April 1944, southeast of Stettin. Daylight sorties by night-fighters commenced during early 1943 in an effort to combat USAAF daylight bombing raids. Manned by inexperienced crew, they were finally abandoned in early 1944 as the growing number of US escort fighters made their continued use expensive in aircraft and personnel.

Radar problems

The radar situation was not looking so healthy. Attempts to perfect anti-jamming equipment, such as Würzlaus and Nürnberg, to counter the effect of Window were not proving successful. An improved Lichtenstein, the SN-2, which was partially unaffected by Window, was in the pipeline but unlikely to be available in quantity for some months. In desperation, it was even suggested that night-fighters should be re-equipped with Spanner-type infra-red devices such as had been used in the earliest days of the night campaign. Finally, it had to be conceded that Himmelbett could not be salvaged and the whole system would have to be abandoned.

Kammhuber did not long survive his brainchild. On 15 September 1943 he was replaced as GOC XII. Fliegerkorps by Generalmajor Josef 'Beppo' Schmid. He remained titular head of the night-fighter force as General der Nachtjagd for several weeks more, before departing for Scandinavia and the command of Luftflotte 5 in November.

The Nachtjagdwaffe Schmid inherited was in a parlous state. Losses had risen sharply in August and showed no sign of falling. JG 300

This became an increasingly common sight during 1945, as the night-fighter force was grounded by a lack of fuel. Although camouflaged against Allied fighter-bomber attack, scores of Luftwaffe night-fighters were destroyed on the ground.

Messerschmitt Bf 110G-4b/R3 5./NJG 5 Hagenau April 1944

Oberleutnant Wilhelm Johnen, Staffelkapitän of 5./NJG 5, flew this newly delivered Bf 110G-4 on the night of 28 April 1944. Having downed an RAF bomber, his 18th kill, he pursued another aircraft as it strayed into neutral airspace over Switzerland. Hit by Swiss flak, which knocked out an engine, Johnen was forced to land at Dübendorf.

Engine exhausts
The elaborate exhaust system provided effective flame damping but was a source of considerable drag. Towards the end of the war, simplified 'straight through' exhausts were fitted.

External fuel
At the expense of aerodynamic efficiency, Bf 110 night-fighters often carried a pair of 900-litre (198-Imp gal) drop tanks to improve range and endurance.

Camouflage and markings
Given their operating environment, it was not long before night-fighters' markings were toned down. This aircraft has a two-figure unit code in black preceding the *Balkenkreuz*, followed by the individual aircraft letter and the Staffel code, also in black. The mottled grey camouflage was typical, with black or grey undersides.

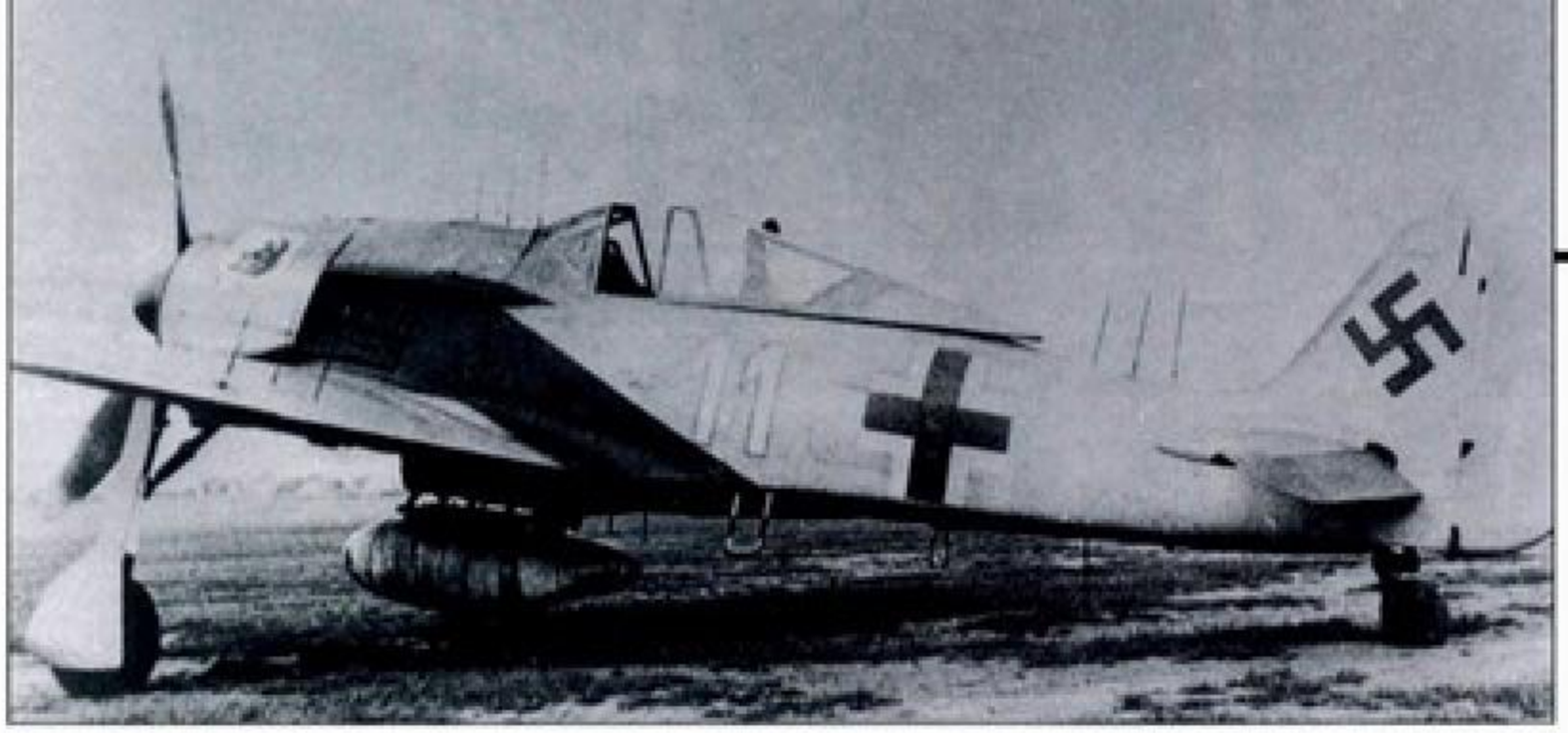
'Traded' for a dozen Bf 109s
The arrival of this aircraft at Dubendorf, Switzerland on 28 April 1944 caused the Luftwaffe high command considerable discomfort, given the fact that it carried radar equipment that had only been in service a matter of months. Worried that it would fall into Allied hands, Göring offered the Swiss government 12 Bf 109G-6s in return for the Bf 110's guaranteed destruction. This was carried out on 19 May in the presence of German personnel.

Defensive armament and *schräge Musik*
For defensive purposes, two 7.9-mm MG 81 machine-guns were mounted in the rear cockpit, along with a pair of 20-mm MG 151/20 cannon in an upward-firing *schräge Musik* installation with which to attack Allied aircraft from beneath.

Kill markings
'C9+EN' displayed 17 of Johnen's eventual 34 kills in the usual position, on the aircraft's tailfin and in the 'traditional' manner of the Nachtjagd. This consisted of a white bar with a diagonal red stripe surmounted by a roundel (or other insignia, as appropriate) and the date of the kill.

FuG 220 SN-2b
The FuG 220 SN-2b set had a maximum range of 4 km (25 miles) and a minimum range of 300-500 m (984-1,640 ft). Its search angles in azimuth and elevation were 120° and 100°, respectively, and the set weighed 70 kg (154 lb). In order to address its minimum range limitations, SN-2b incorporated a FuG 212 Lichtenstein C-1 Weitwinkel (wide-angle) radar, the smaller antenna for which was positioned 'inside' the central main array.

Offensive armament
Basic Bf 110G-4 armament consisted of two 20-mm MG 151/20 cannon and four 7.9-mm MG 17 machine-guns. This aircraft sports Rüstsätze field modification R3, which replaced the machine-guns with a pair of MK 108 cannon in an underfuselage pack.



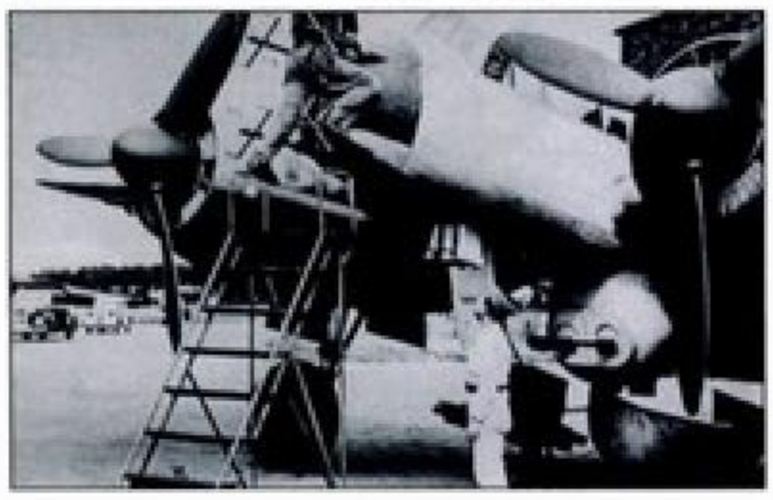
Radar was eventually tested in Bf 109s and Fw 190s with a view to giving Wilde Sau aircraft some means of finding their quarry other than the 'Mark 1 Eyeball'. The latter type was chosen for operations due to its heavier armament, examples of Fw 190A-5s, A-6s, A-8s and A-9s being so-equipped. Most served with NJG 11, though this is a 1./NJGr 10 aircraft. The fuselage arrays for FuG 217 Neptun J-1 are clearly visible, along with wing antennas for FuG 217RV distance-measuring radar.

was in a particularly bad way. The 'twinning' scheme was not working. The day-fighter pilots, whose aircraft were being used, were justifiably concerned at the high rate of attrition; many of their machines suffered combat damage or were written off in heavy night landings. More often than not, shortage of fuel after a long nocturnal chase forced them to land away from base, which severely impaired the next day's operations by the Jagdflieger.

With no better alternative, on 26 September Göring ordered the activation of two more single-seat night-fighter units, JGs 301 and 302. He made sure, however, that they – like JG 300 – were subordinated to the General der Jagdflieger and not the General der Nachtjagd, in whom he had lost all confidence.

At this point, the Nachtjagdgruppen were offered a glimmer of hope with the introduction of two passive homing devices. Flensburg could pick up the emissions from a bomber's Monica tail-warning radar from a distance of 100-200 m (328-656 ft). Of far greater significance, Naxos could detect a pathfinder bomber using H_2S at a range of 50 km (31 miles). This did not prevent two devastating raids early in October, against Kassel on the night of 3/4 and Bremen five nights later, which completely wrong-footed the defenders. Although there were mitigating circumstances on both occasions, the 'system' was blamed for the night-fighters' poor performance. It was the final nail in Kammhuber's coffin. It also led to a reorganisation of night-fighter command. XII. Fliegerkorps was disbanded and replaced by I. Jagdkorps, the command's component divisions being reduced from five back to three.

This radar-equipped Ju 88P was used for operational trials of a pair of movable MK 103 cannon in a ventral tray, though the installation proved to be too unwieldy for night-fighters.



Battle of Berlin

On the night of 18/19 November, Bomber Command opened the Battle of Berlin with the first of a series of major raids on the German capital which lasted well into the New Year. It was a testing time for the Nachtjagdwaffe. Despite all their handicaps, they took a steady toll of the attacking forces but were simply overwhelmed by weight of numbers. These numbers not only allowed Bomber Command to bear the average 5 per cent losses sustained in their attacks on Berlin, but also enabled them to mount increasingly complex and large-scale diversionary operations. The Luftwaffe's response to the latter was the activation of seven Luftbeobachterstaffeln (air observation squadrons) to track and report the main bomber stream.

The RAF was gaining the ascendancy on every side. Serrate-equipped Beaufighter night-fighters, able to home on the radar signals of German night-fighters, had long been a menace over northwest Europe; Hauptmann August Geiger, a 53-victory *Experte* of 7./NJG 1, had fallen victim to one such over the Zuider Zee on the night of 29/30 September. Now that the Beaufighters were giving way to similarly-equipped, longer-legged Mosquitos, danger lurked in every corner of the Reich.

An annoyance rather than a danger was Corona, the transmission of fake messages from England on the Luftwaffe's night-fighter control frequencies. Introduced in October, the intention of Corona was to spread confusion among the night-fighter crews by issuing them with false instructions. Many heated exchanges ensued over the next few weeks as the German-speaking English 'controller' and his genuine Luftwaffe opposite sought to convince the bemused aircrew that his was the real voice of authority and the one to be obeyed. When the Germans introduced females to transmit the instructions, the RAF trawled the 'WAAFeries' for bilingual airwomen. Gradually, however, the game was abandoned and more orthodox jamming procedures were used to prevent orders being heard and understood. These the Luftwaffe tried to counter with loud, themed music. A sea-shanty blaring out of his headphones would send a pilot hot-foot towards Hamburg, dance and carnival music to Berlin and Cologne, respectively, and a beer-hall singalong to Munich!

On 17 November 1943 the loss of one of the oldest of the old guard was keenly felt throughout the Nachtjagdwaffe. Major Walter Ehle, who had been Gruppenkommandeur of II./NJG 1 since October 1940, was returning from that night's operations over Mannheim and preparing to land back at St Trond when the airfield lighting suddenly and inexplicably failed. Presumably disorientated, Ehle crashed and was killed, together with his crew.

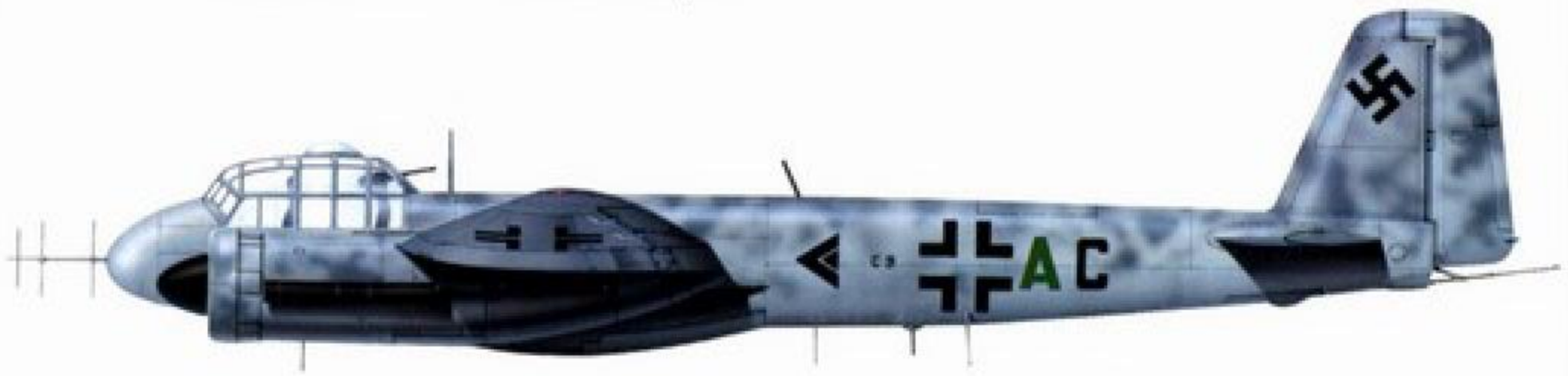
The year ended on a more optimistic note. Airborne SN-2 radar was becoming more widely available, as were the Flensburg and Naxos homers. Bomber Command's continuing offensive against Berlin was not being carried out without cost. On the night of 16/17 December, for example, nearly 500 Lancasters were dispatched to the Reich's capital. Despite extensive jamming and various decoy operations, 28 night-fighters were inserted into the main stream (by 'Y'-guidance) between Bremen and Osnabrück, and another 30, mainly Bf 110s of NJG 5 flying Wilde Sau, were waiting for them over the target area. Between them, the fighters accounted for 18 of the night's 25 combat losses. Oberleutnant Heinz-Wolfgang Schnaufer, Staffelkapitän of 12./NJG 1, claimed four, including one of the master bombers whose job it was to remain over the target supervising and co-ordinating the attack.

1944, however, did not bring the hoped-for resurgence of Nachtjagdwaffe fortunes, but rather a steady and inexorable decline. The attackers' numerical superiority – something in the region of 5:1 – was unassailable. German scientists were losing the electronics war and, on a more prosaic level, the shortage of aviation fuel was having an increasing impact as the year progressed. Despite this, aircrews continued to give their best, as witnessed by the 46 Knight's Crosses awarded during that year (27 more than in 1943). More statistics graphically illustrate the price paid: 1944's losses totalled half as many

As the shadows lengthen on an East Prussian airfield in the autumn of 1944, a Ju 88G-6 of Stab I./NJG 100, recently returned from the Eastern Front, is relieved of its tarpaulin covers and prepared for a night's operations, probably in 1944. In the left background is another aircraft, well-camouflaged with tree branches against air attack.

Later Ju 88G/FuG 220 combinations

An early champion of *schräge Musik*, Major Rudolf Schoenert flew this Ju 88G-6 while Geschwaderkommodore of NJG 5 between March and May 1945. 'C9+AA' served as a radar testbed, equipped with two extra FuG 220 radar arrays either side of the rear fuselage. Note also the Naxos ZR antenna, usually associated with Lichtenstein SN-2d.



Gruppenkommandeur of II./NJG 5 at Hagenau in late 1944, Major Hans Leickhardt was one of the few pilots to use a Ju 88G-6 operationally with a Morgenstern array for its FuG 220 radar. Leickhardt was killed on 5 March 1945.

again as all the previous years combined.

These losses were not confined to the inexperienced lower ranks. The enforced practice of sending up the more successful crews in order to ensure the requisite number of kills was in itself a vicious circle. The more frequently they were employed, the greater the casualty rate was among experienced and irreplaceable formation leaders. In action against a major raid on Magdeburg on the night of 21/22 January, the Nachtjagdwaffe suffered a double blow. Major Heinrich Prinz zu Sayn-Wittgenstein, Kommodore of NJG 2, fell victim to an RAF night-fighter after he himself had claimed five bombers. I./NJG 1 lost its Gruppenkommandeur – another 50+ *Experte* – when Hauptmann Manfred Meurer's He 219 collided with a Lancaster.

New aircraft – Ju 88G and Ta 154

On the plus side, January 1944 saw the virtual abandonment of the night-fighters' costly daylight operations, the delivery of the first of the new, improved Ju 88G models, and the activation of Nachtjagdgruppe 10. This latter, commanded by Hauptmann Rudolf Schönert, was an experimental unit whose three component Staffeln were tasked with testing new types and equipment. 3./NJGr 10 had a brief flirtation with the Luftwaffe's 'answer' to the RAF's Mosquito, but the propensity of the all-wooden Ta 154 Moskito to come apart in mid-air – the result of faulty bonding agents – made the machine somewhat less than suitable for its intended purposes. More promising were 1. Staffel's trials with the family of new Neptun airborne radars, which did enter operational service, albeit in only very few numbers and right at the close of the war.

In the meantime, the Battle of Berlin was also drawing to a close. The last raid of the series – in fact, the last major bombing attack of the war on Hitler's capital – was mounted on the night of 24/25 March 1944. The defending fighters claimed the destruction of 81 bombers, nine more than the actual total lost to all causes. The true figure was bad enough for Bomber Command, but it was eclipsed six nights later when they set out to raid Nuremberg.

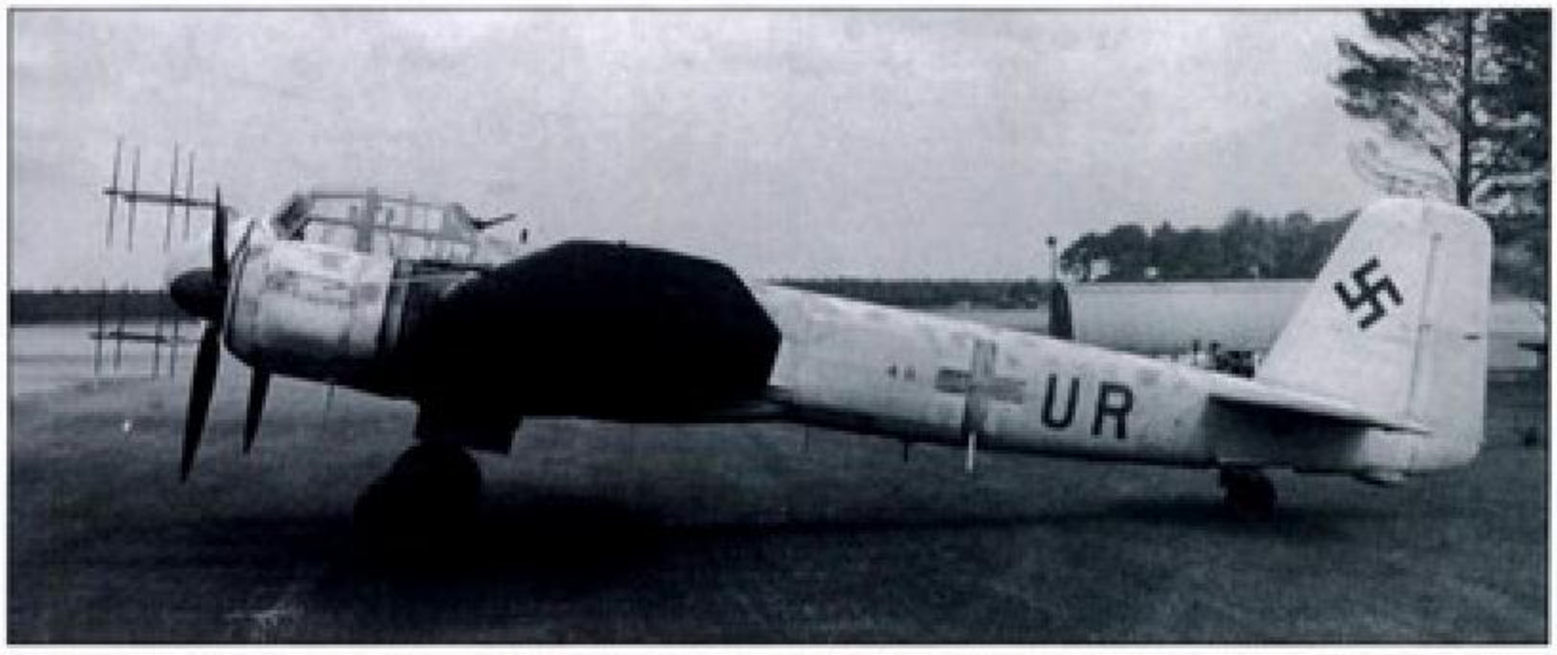
The path of the bomber stream, nearly 800-aircraft strong, en route for Nuremberg took it directly between two radio beacons – 'Ida', south of Aachen and 'Otto', east of Frankfurt – where the Luftwaffe controllers were already assembling their fighter forces. Protective cloud had been forecast for the attackers, but the meteorologists had got it wrong. For the next hour, in bright moonlight, the bombers were savaged as they grimly held course for the target. The night-fighters made the most of their unexpected opportunity, as can be read in this anonymous account, published in the German Fighter Pilots' Association magazine *Jägerblatt*, in the 1960s:

"Suddenly we were right in the middle of them. Bearing 120° to 150°. The flak is hammering away. There's one going down. And another. Then more and more. Soon there's one just ahead of us. I'm unused to this bright light and miss with my first burst of fire. A second produces just dull thuds. Stoppage! I quickly pull away and clear my weapons. A short test burst. Two of my cannons are U/S.

"Bombers are raining down all around us – complete mayhem. I've never experienced a night like it. 00.45 hours, 5700 m altitude. Achtung! Off to the left, 300, 200, ... A huge shape looms past us. I almost rammed him! Ease under him and reduce power. One hundred metres. I let fly. He wanders in from the right across my line of fire. His fuselage and starboard inner immediately burst into flames. I pull off to the right and catch a fleeting glimpse of his markings. N and MP? Then he's falling away behind us to the left. 00.49 hours, he hits the ground in the hills to the north-west of Würzburg."

This bomber – possibly Halifax LW724 of 158 Squadron – was just one of the 82 brought down on the outward leg. Exactly 60 seconds prior to the Halifax's demise, Oberleutnant Helmut Schulte, Staffelkapitän of 4./NJG 5, had claimed a Lancaster – another master bomber, to judge from the 'fireworks display' which erupted from the resultant explosion. Schulte then shot down a further three bombers, all four being despatched with just 56 rounds of *schräge Musik*.

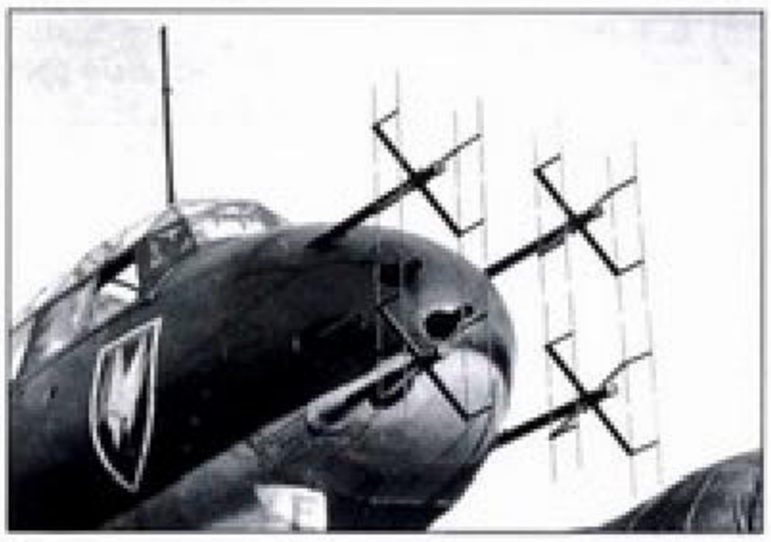
The slaughter abated on the return flight, but the final total of 95 bombers downed represented Bomber Command's largest single operational loss of the entire war. It was also the



The arrival of Ju 88G-1 '4R+UR' of 7./NJG 2 at RAF Woodbridge on 13 July 1944 was another costly loss for the Luftwaffe, giving away, in particular, the secrets of Naxos Z and alerting Bomber Command to the risks associated with the use of H_2S over enemy territory.

From Lichtenstein to Morgenstern – Radar development 1942-45

During 1942 British monitoring stations became increasingly aware of references by Nachtjagdwaffe crews to a device called 'Emil-Emil'. Radio transmissions between Himmelbett controllers and NJG crews made clear reference to this equipment, but the Royal Air Force had no idea what its frequency might be. When a monitoring receiver in Norfolk picked up transmissions likely to have come from AI radar, curiosity was further aroused. In the first electronic ferret mission of its type, a Wellington Mk IC fitted with an appropriate receiver was flown 'into the lion's den' on 3 December 1942. Though attacked and badly damaged by a Ju 88, it managed to escape with details of 'Emil-Emil' emissions. Just six months later an NJG crew defected with its Ju 88R-1, equipped with 'Emil-Emil' – a device known as FuG 202. With its successor, FuG 212, FuG 202 was in widespread use by late 1943 and was followed by a myriad of new radar devices, each the result of advances in technology and changes to stay ahead of RAF countermeasures.

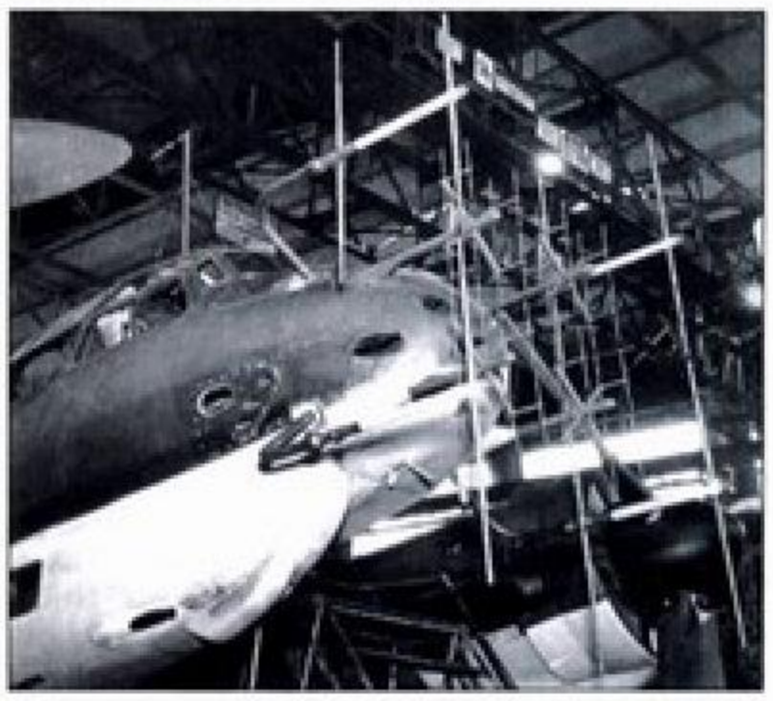


The first Luftwaffe AI radars, FuG 202 Lichtenstein BC and FuG 212 Lichtenstein C-1 shared a common array, seen on a Ju 88R-1 (above) and Do 217N-2 (below). Converted from bombers, the latter was armed with four MG 151/20 cannon and four MG 17 machine-guns.

Below: The nose array on this Stab I./NJG 4 Bf 110G-4 belongs to a FuG 220 Lichtenstein SN-2d set. Developed from FuG 213 ASV radar and characterised by its much larger, so-called Hirschgeweih *(stag's antlers) array, SN-2 entered production in September 1943 and equipped most Luftwaffe night-fighters, in some form or other, until war's end. Note the FuG 227 Flensburg receiver antenna on the wingtip.*

Above: Ju 88G-1 '4R+UR' of 7./NJG 2 was landed in error at RAF Woodbridge by Obgfr John Mäckle on a flight from Twenthe on 13 July 1944. Equipped with FuG 220, FuG 227 and FuG 350, the last two of which were unknown to the RAF, the aircraft proved to be an important capture which saved the lives of countless RAF bomber crews. FuG 227 Flensburg was a homing device used to track the RAF Bomber Command's Monica active tail warning radar, while FuG 350 Naxos Z homed on Allied H_2S navigation radar.

Left: The complex array carried by a Bf 110G-4b is seen here. With a minimum range of 300-500 m (984-1,640 ft), FuG 220 SN-2 was hampered somewhat in close combat, so SN-2b incorporated a FuG 212 Lichtenstein C-1 Weitwinkel (wide-angle) radar, positioned 'inside' the central main array.

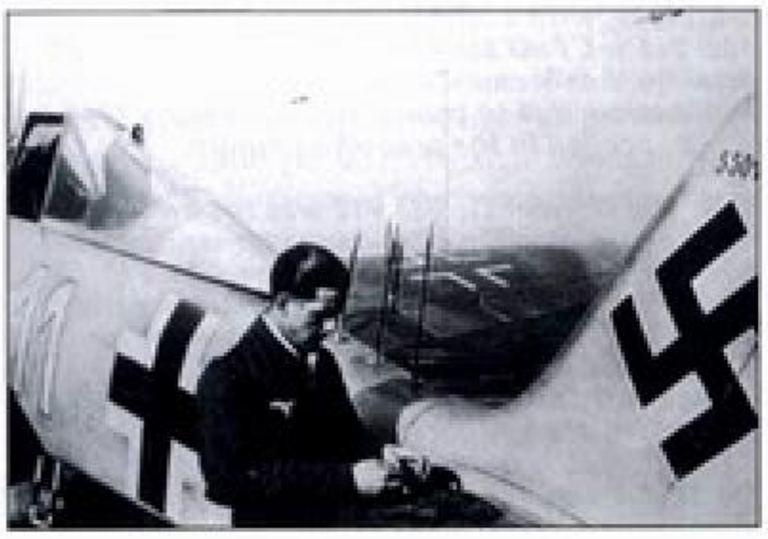


Above: The first SN-2b installations combined a complete FuG 212 Lichtenstein C-1 array with the SN-2 antenna. The result was the complex arrangement seen on this Ju 88C-6c.

Above: The FuG 220 array on this BMW 801-powered Ju 88R-2 has curved main supports with unusual strengthened mountings.

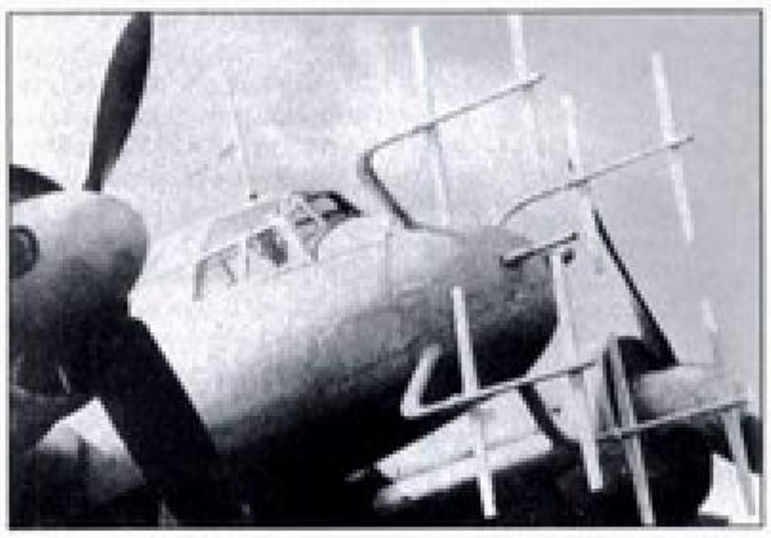
Above: Though of poor quality, this photograph shows a Ju 88G-6 (possibly a Stab II./NJG 5 machine) equipped with an experimental Morgenstern (Morning Star) array for FuG 220. A partially-enclosed version with a cone-shaped fairing over the central dipole was also built. At least one aircraft (coded 'C9+AA' and flown by Major Rudolf Schönert) was equipped with yet another FuG 220 antenna variation in which aerials were arranged vertically above and below the rear fuselage.

Right: The angled aerials of the FuG 220 array on this Ju 88G-6 indicate the later SN-2d variant, while the fairing above the cockpit contains a FuG 350 Naxos receiver. Also notable on this aircraft are the exhaust dampers and a twin 20-mm MG 151/20 cannon pack under the centre-section.

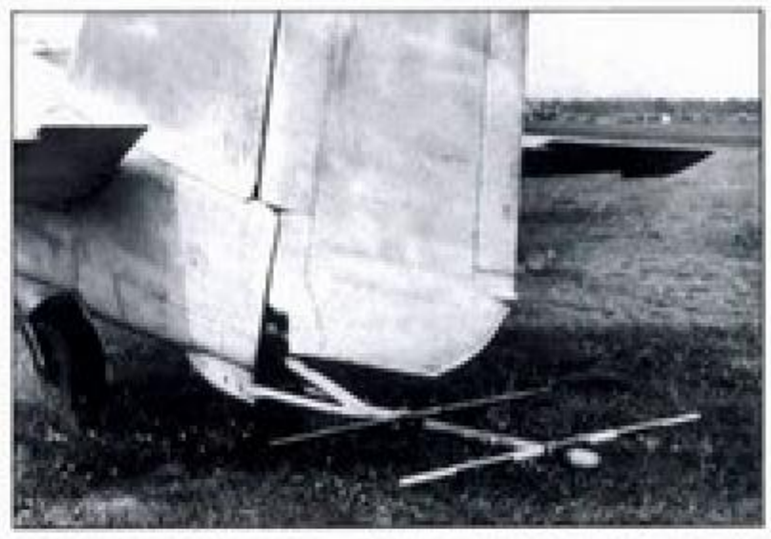


Above: In its Neptun J-1 variant, FuG 217 AI radar could be installed in a single-seat aircraft, like this Wilde Sau Fw 190A-6 of 1./NJGr 10. Note the dipoles forward of the cockpit. In the foreground is Oberleutnant Hans Krause, one of 1./NJG 10's most successful pilots. Krause finished the war a Hauptmann, with 28 kills.

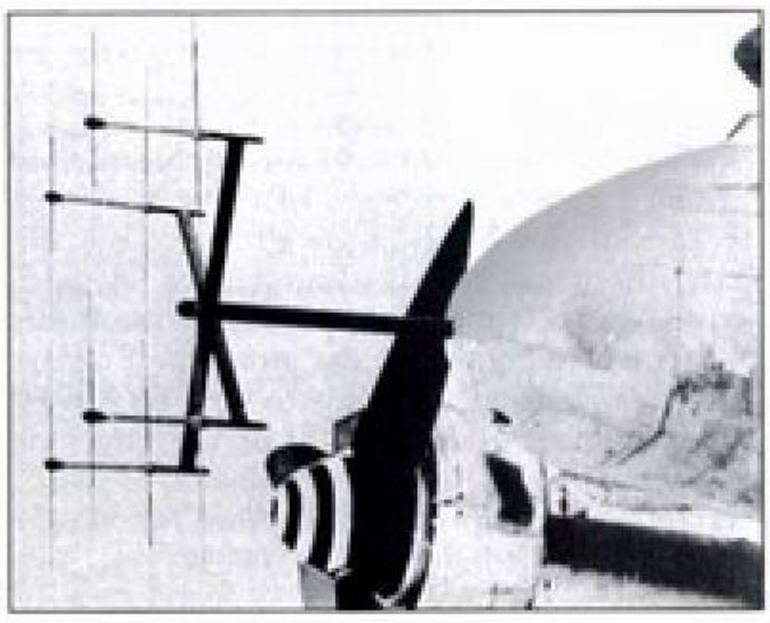
Below: The same aircraft also sports arrays on its wings for FuG 217RV, a distance-measuring radar used in conjunction with EG 3 Elfe 3 – an automatic gun-firing device.



Above: Blade antenna distinguished the FuG 228 Lichtenstein SN-3 radar array which had a range of 250-8000 m (820-26,250 ft). Only 10 sets are believed to have been delivered and there is no evidence that they were used operationally.

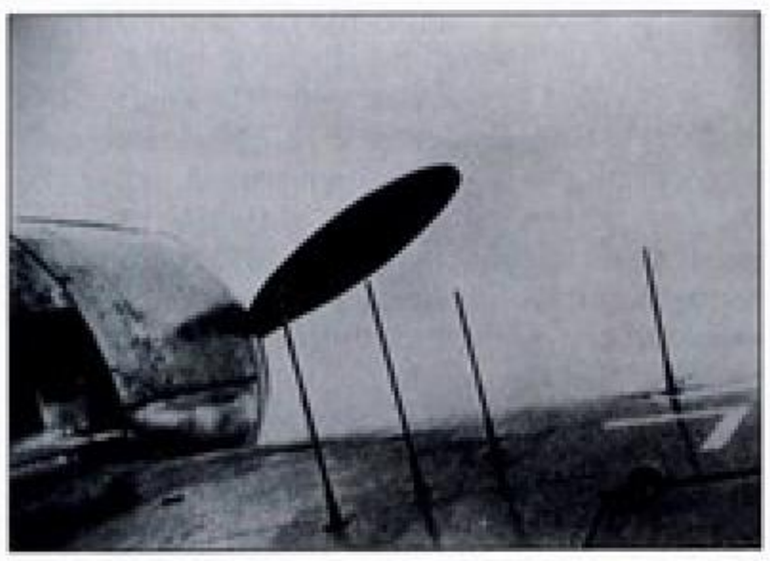


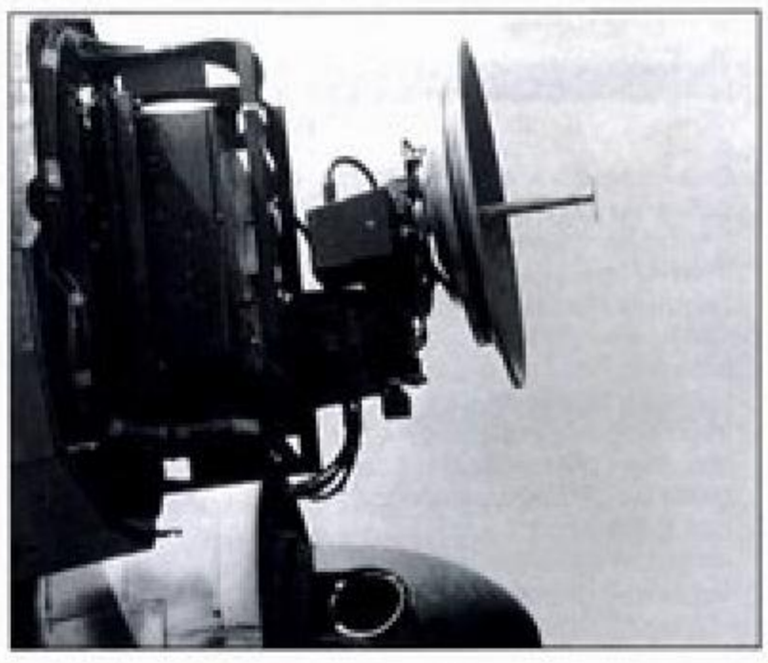
Above: A variation on FuG 350 was Naxos ZR (seen here on a Ju 88G-6), which added this tail-mounted antenna to provide a tail warning capacity. At least 700 Naxos Z and ZR sets saw operational service. The same device was used by the German navy to warn U-boats of the presence of Allied ASV radar-equipped aircraft.



Above and above right: FuG 218 Neptun V/R was a combined AI and tail-warning radar that saw limited use on Ju 88s and Bf 110s in the last months of the war. Its nose array for the AI component (Neptun R) resembled that of FuG 220, but used a single, central support. The tail-warning set (Neptun V) used an antenna positioned on the tailfin, just forward of the stern post.

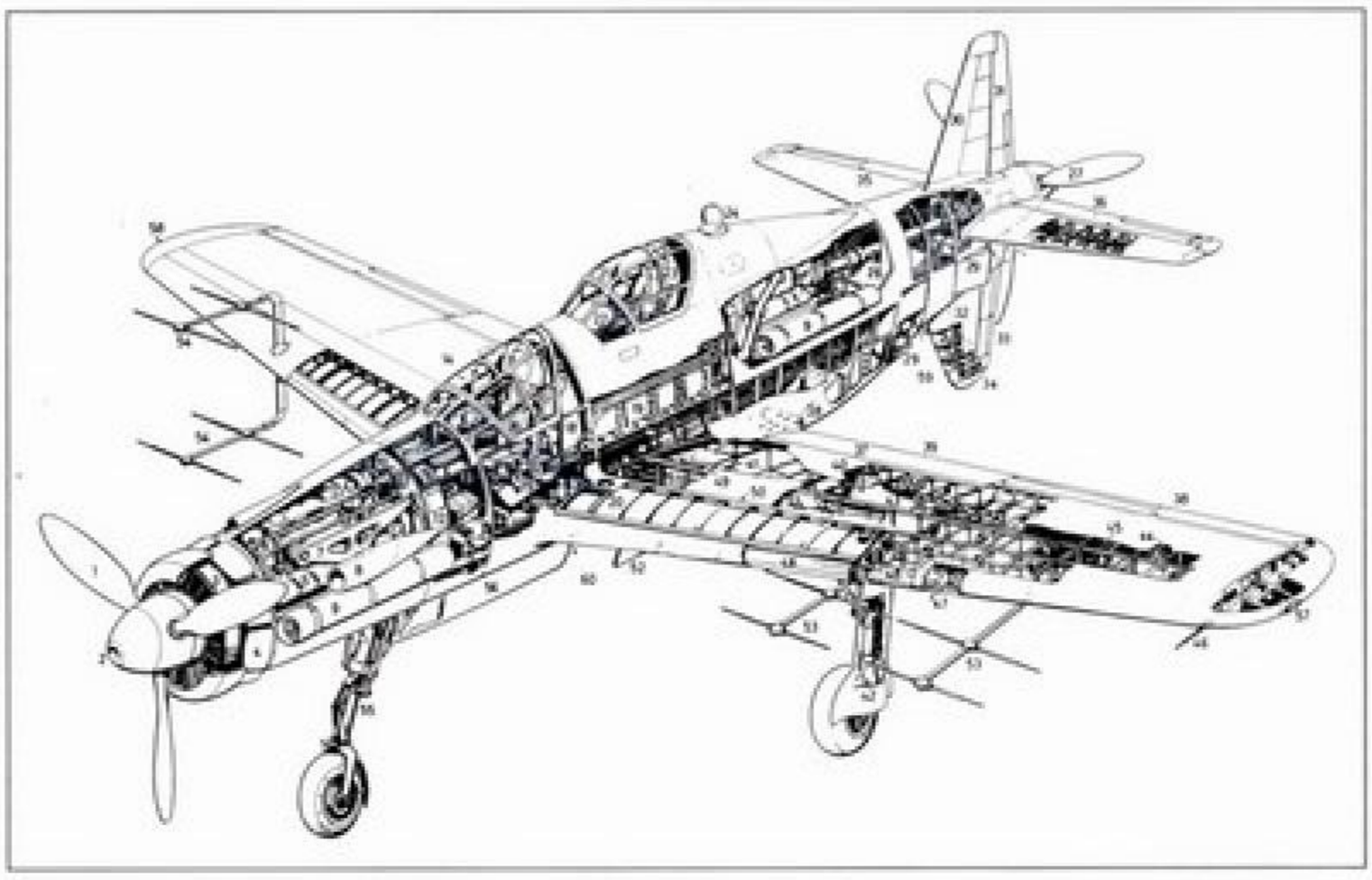
Below and below right: Surrendered at Flensburg, Ju 88G-6 '3C+MN' of II./NJG 4 sported a centimetric FuG 240/1 Berlin N-1a radar in its thimble nosecone. Derived from H_2S (an intact set having reportedly fallen into German hands on Christmas Eve, 1942), FuG 240 was virtually immune from the effects of Window. However, only 25 sets were completed before war's end, and only 10 were installed in Ju 88s.





Prototypes

Radar-equipped variants of a number of late-war fighters and bomber prototypes, both jet-powered and piston-engined, were proposed. Included among these were night-fighter versions of Arado Ar 234 Blitz, Dornier Do 335 Pfeil and Junkers Ju 388.



Above: The BMW 801-powered Junkers Ju 388 was born out of the failure of the 'Bomber B' programme and was proposed in three basic configurations – bomber, reconnaissance aircraft and high-altitude night/bad-weather fighter. Ju 388 V2 (seen here) was completed as the prototype for the Ju 388J night-fighter, with SN-2 radar and an MG 131Z/FA 15 remotely-controlled twin-gun tail barbette. Initial production Ju 388J-1s would have been equipped to a similar standard as the later V4 prototype, with a Morgenstern array for a FuG 218 set, FuG 350 Naxos Z and an MG 151/20 schräge Musik cannon installation. Production, due to commence in January 1945, was cancelled in the preceding month.

Left: The Dornier Do 335 V10 was the prototype for the proposed Do 335A-6, a radar-equipped, two-seat, all-weather/night-fighter. The V10 featured a second cockpit for a radar operator using a FuG 217 Neptun J-2 set, antennas for which were positioned on each wing. To compensate for a 1,058-lb (480-kg) increase in loaded weight and for the drag generated by flame-damping tubes on its exhausts, the Do 335A-6 would have been powered by DB 603Es with MW 50 methanol-water injection. Had it entered production, the A-6 would have been built by Heinkel in Vienna.

Nachtjagdwaffe's last great success.

The reduction in the number of raids on central Germany following Nuremberg was not a result of that undoubted disaster, but a strategic transfer of bombing resources to more westerly targets in preparation for the forthcoming invasion of Normandy. The Luftwaffe responded to this westward shift by transferring a number of Nachtjagdgruppen (including II. and III./NJG 1 and I./NJG 5) forward into France, promptly bringing them within easy range of Allied fighter-bombers. Hitherto, daylight attacks on night-fighter bases had been carried out mainly by US heavies. The 8 April raid on Quackenbrück, for example, had hit II./NJG 2 hard, destroying a number of its Ju 88Rs on the ground and causing many aircrew casualties. Fighter-bomber attacks began to inflict so much damage that the Luftwaffe's night-fighters were initially dispersed to smaller, satellite landing grounds in eastern France and then withdrawn from the danger zone altogether.

When it came, the invasion of Normandy provided graphic evidence of the sad state of decline of the Nachtjagdwaffe. Against the many thousands of Allied aircraft of all types active over occupied Europe during the hours of darkness leading up to the morning of 6 June 1944, the Luftwaffe was able to send up just 59 night-fighters. Nearly 1,200 of the attackers were machines of Bomber Command, of which exactly eight were lost, only one reportedly falling to a night-fighter.

Ill-suited operations

The Normandy campaign marked perhaps the last significant milestone in the history of the night-fighter force. Only relatively recently released from costly daylight sorties in defence of the Reich, many of the younger and less-experienced aircrew found themselves engaged on another kind of operation for which they were equally ill-suited: night ground attack. The first such missions were flown by II./NJG 4 and III./NJG 5 in an attempt to prevent the Allies from breaking out of their Normandy bridgehead. Thereafter they were mounted with increasing frequency as German forces began their general withdrawal and sought by every means possible to hamper the Allied pursuit.

This set the pattern for the latter half of 1944. With Bomber Command resuming its nocturnal assault on Germany proper, the Nachtjagdwaffe was effectively being called upon to wage war on two fronts: combating both the renewed aerial onslaught on the Reich and the advance of the Allied ground armies. It was an impossible task. All the night-fighter arm could produce against the Allies' by now overwhelming superiority were some local tactical and individual aircrew successes. Some of these latter were indeed spectacular, and would remain so until the very end, but they had not the slightest

Nocturnal Schwalbe

One of seven Me 262B-1a/U1s delivered to 10./NJG 11 (the former Kommando Weltner), 'Red 12' was the mount of Leutnant Herbert Altner in May 1945, when the unit was based at Reinfeld (near Lübeck). Equipped with FuG 218 Neptun V radar and carrying a pair of 300-litre drop tanks on ETC 503 weapons racks, the aircraft was surrendered to the British at Schleswig-Jagel and was later shipped to the UK.

effect on the course of hostilities. By the close of the year, night-fighters were accounting for less than 1 per cent of the bombers being dispatched against them. Adolf Galland, whose own position as General der Jagdflieger was far from secure, was moved to describe the Nachtjagdwaffe's contribution to the overall war effort as 'meaningless'.

The night-fighters' growing dependence on SN-2 radar had received a severe setback at the height of the Normandy campaign when, on 13 July 1944, a Ju 88 of 7./NJG 2 landed at Woodbridge in Suffolk. Unlike an earlier arrival in the United Kingdom (a Ju 88R-1 of IV./NJG 3), the crew of this newcomer were not defectors but the victims of navigational equipment failure – they believed they were landing at Venlo in Holland. Unfortunately, their Ju 88G-1 '4R+UR' was fully equipped with SN-2, Flensburg and Naxos. It was a major intelligence prize for the RAF, enabling it to develop effective countermeasures (such were Bomber Command's material resources that it now deployed an entire Group, No. 100, devoted solely to RCM warfare).

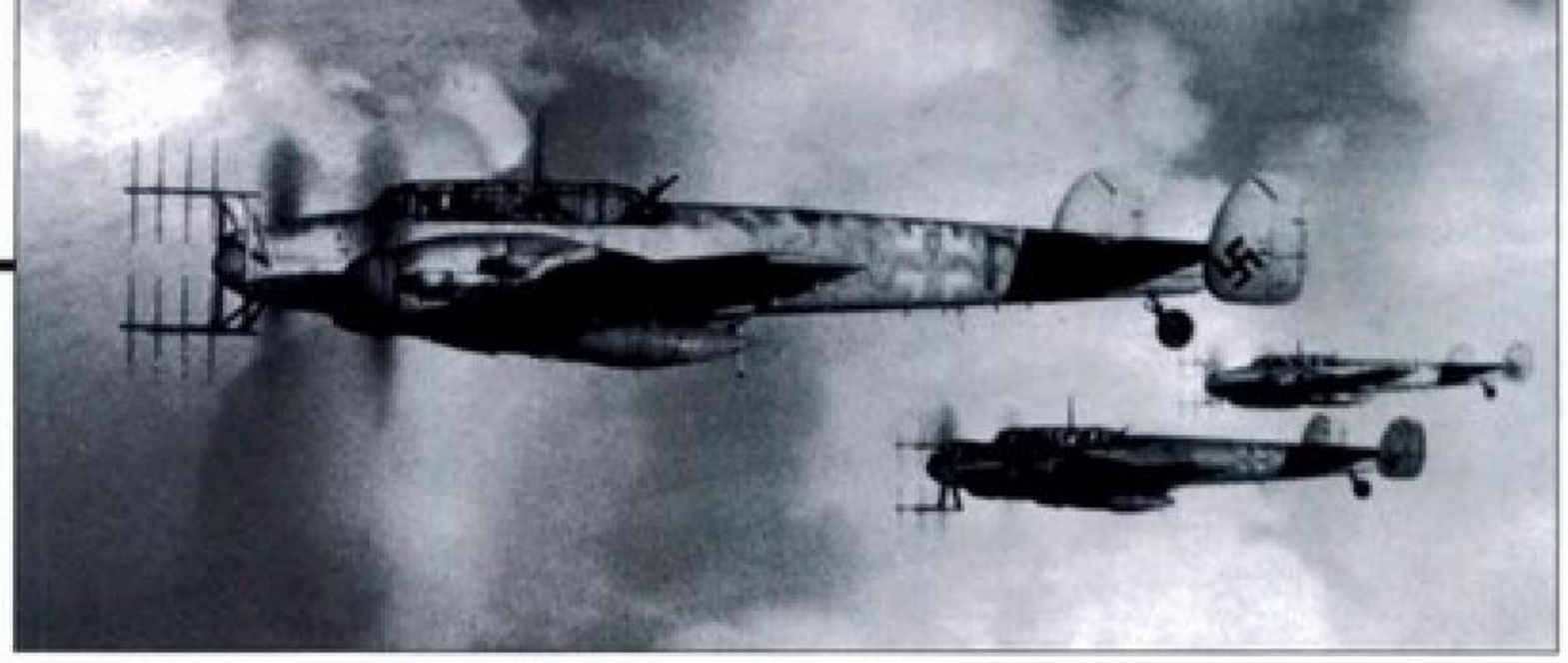
For its part, the Luftwaffe did the best it could with the means at its disposal. To compensate for the loss of the three original Wilde Sau Geschwader (JGs 300-302), which had been remustered as day-fighter units, three semi-autonomous experimental Gruppen of single-seaters were activated under the designation NJG 11. Their task was to continue with the trials of new equipment initiated by NJGr 10 and, specifically, to find a means of combating the ubiquitous Mosquitos. Meanwhile, the operational units were forced to revert to a simpler form of Kammhuber's original Himmelbett system. Known as Gebietsnachtjagd (literally, area night-fighting), this entailed aircraft orbiting in the major approach routes known to be used by the RAF, controlled not by radar, but by VHF radio messages.

Night ground-attack sorties

As Allied ground forces advanced into the Low Countries, many long-established night-fighter airfields had to be evacuated. In September 1944 elements of NJG 1 flew night ground-attack missions against the abortive British airborne landings at Arnhem, close to their one-time base at Arnhem-Deelen. These ground-attack operations continued until the year's end, reaching their peak during the German counter-offensive in the Ardennes when aircraft from four Geschwader (NJGs 1, 2, 3 and 6) mounted nearly 400 sorties.

During December a small Kommando of Me 262 jet night-fighters was set up under Oberleutnant Kurt Welter, an ex-flying instructor and, more recently, Wilde Sau pilot, who already had several Mosquitos to his credit. Now, with the Me 262, the Nachtjagdwaffe finally possessed the long-sought answer to the RAF's 'Wooden Wonder'. During its brief existence, and in the course of some 160 sorties, this small Me 262 unit (whose strength rarely reached double figures) claimed almost 50 kills, the vast majority of them Mosquitos. Like so much else at this stage of the war, though, it was 'too little, too late'.

For a few night-fighter aircrews the first mission of 1945 involved acting as 'navigational 'guides', leading the large formations of young



Above: Though fuel supply problems often left its aircraft grounded, when it could get into the air the Nachtjagdwaffe was a potent force until the war's end. These Bf 110s from an unidentified unit are seen on a daylight sortie – a highly risky tactic abandoned in 1944 as USAAF bombers became more heavily armed.

Right: How the mighty have fallen: an He 219, arguably the Luftwaffe's best night-fighter, is reduced to just a handy perch from which to take a snap of advancing US armour!

Nachtjagd Order of Battle, April 1944

UNIT	BASE	AIRCRAFT
Defence of the Reich		
LUFTFLOTTE REICH (HQ: Berlin-Wannsee)		
7. Jagddivision (HQ: Schleissheim)		
Stab NJG 6	Schleissheim	Bf 110 (2/1)*
II./NJG 6	Schleissheim	Bf 110 (13/11)
Stab NJG 101	Ingolstadt	? (?/?)
I./NJG 101	Ingolstadt	Bf 110, Ju 88 (39/39)
Stab NJG 102	Kitzingen	? (?/?)
II./NJG 102	Echterdingen	Bf 110 (39/16)
Stab JG 301	Schleissheim	? (?/?)
I./JG 301	Neubiberg	Bf 109 (25/21)
Luftbeobachterstaffel 7	Echterdingen	Bf 110
Jafü Ostmark		
II./NJG 101	?	Do 217 (38/28)
II./JG 301	Vienna-Seyring	Bf 109 (?/?)
I. Jagdkorps (HQ: Driebergen)		
1. Jagddivision (HQ: Döberitz)		
Stab NJG 5	Döberitz	Bf 110 (3/1)
I./NJG 5	Stendal	Bf 110 (15/9)
II./NJG 5	Parchim	Bf 110 (19/13)
IV./NJG 5	Erfurt	Bf 110 (18/8)
I./NJG 2	Kassel	Ju 88 (31/21)
NJGr 10	Werneuchen	various (23/14)
III./JG 301	Zerbst	Bf 109 (?/?)
Luftbeobachterstaffel 1	Neuruppin	Bf 110 (?/?)
Jafü Ostpreussen		
V./NJG 5	Insterburg	? (?/?)
2. Jagddivision (HQ: Stade)		
II./NJG 2	Deelen	Ju 88 (33/19)
Stab NJG 3	Stade	Ju 88, Bf 110 (3/3)
I./NJG 3	Vechta	Bf 110 (26/22)
IV./NJG 3	Aalborg	Ju 88, Bf 110 (32/21)
II./JG 302	Ludwigslust	Bf 109 (?/?)
Luftbeobachterstaffel 2	Stade	Bf 110 (?/?)
Jagdabschnittsführer Dänemark		
10./NJG 3	Grove	? (?/?)
NJKdo 190	Aalborg	Fw 190 (?/?)
3. Jagddivision (HQ: Deelen)		
Stab NJG 1	Bonninghardt	He 219, Bf 110 (2/1)
I./NJG 1	Venlo	He 219, Bf 110 (33/26)
II./NJG 1	St. Trond	He 219, Bf 110 (21/11)
III./NJG 1	Athies-Laon	Bf 110 (17/17)
IV./NJG 1	Leeuwarden	Bf 110 (23/14)
Stab NJG 2	Deelen	Ju 88 (4/4)
III./NJG 2	Twenthe	Ju 88 (28/18)
Stab JG 300	Krefeld	Fw 190 (2/1)
I./JG 301	Bonn-Hangelar	Bf 109 (29/19)
II./JG 301	Rheine	Fw 190 (32/23)
EKdo 410	?	Me 410 (?/?)
I./(Bef)KG 7	?	? (?/?)
Luftbeobachterstaffel 3	Venlo	Bf 110 (?/?)

UNIT	BASE	AIRCRAFT
Jagdabschnittsführer Mittelrhein		
II./NJG 3	Schleswig	Ju 88 (37/13)
III./NJG 3	Stade	Bf 110 (29/20)
III./NJG 5	Königsberg/Neumark	Bf 110 (18/8)
I./NJG 6	Mainz-Finthen	Bf 110, Do 217 (24/21)
III./JG 300	Wiesbaden	Bf 109 (27/25)
West Front		
LUFTFLOTTE 3 (HQ: Paris)		
II. Jagdkorps (HQ: Chantilly)		
4. Jagddivision (HQ: St Pol)		
Stab NJG 4	Florennes	Bf 110 (2/0)
I./NJG 4	Florennes	Ju 88 (16/7)
II./NJG4	St Dizier	Ju 88, Bf 110, Do 217 (20/12)
III./NJG 4	Juvincourt	Bf 110, Do 217 (19/10)
East Front		
LUFTFLOTTE 1 (HQ: Malpils)		
EKdo I./JG 302	Helsingfors	Bf 109 (?/?)
3. Fliegerdivision (HQ: Pleskau)		
4./NJG 100	Reval-Laksberg	Ju 88C (7/6)
1./NJG 200	Jakobstadt	Ju 88C (?/5)
LUFTFLOTTE 6 (HQ: Priluki)		
1. Fliegerdivision (HQ: Pinsk)		
1./NJG 100	Bobruisk	Ju 88C, Do 217, Fw 189 (?/5)
4. Fliegerdivision (HQ: Orscha)		
3./NJG 100	Orscha	Ju 88C, Do 217, Fw 189 (?/6)
LUFTFLOTTE 4 (HQ: Morczyn)		
I. Fliegerkorps (HQ: Odessa)		
5./NJG 200	Odessa	Bf 110 (?/9)
South East Europe		
LUFTWAFFENKOMMANDO SÜDOST 1 (HQ: Pancevo/Belgrade)		
Jagdabschnittsführer Rumänien		
IV./NJG 6	Zilitsea	Bf 110 (?/15)
2./NJG 100	Focsani	Ju 88, Bf 110 (?/2)
	Zilitsea	Ju 88, Bf 110 (?/3)
	Otopeni	Ju 88, Bf 110 (?/3)
10./JG 301	Otopeni	Bf 109 (?/8)

Notes: * Figures after aircraft type refer to unit establishment/serviceable aircraft.

Luftbeobachterstaffel = Air Observation Sqn
Jagdabschnittsführer = Fighter Sector Leader
Jafü (Jagdführer) = Fighter Leader

The end in the north: this view of Grove airfield, Denmark was recorded on 9 May 1945. Ju 88s of NJG 3 are seen parked with their propellers removed and canopies and engines covered. Bf 110s are also visible, along with at least one Ju 88 bomber.

Left: This Ju 88G (Wk-Nr 620643, coded '3C+PN') of 5./NJG 4, seemingly abandoned during maintenance, was captured by the British at Wunstorf, near Hannover. One of its starboard Jumo 213 engine rests on drums in the foreground.

Below: These Bf 110G-4s are seen at Fritzlar shortly after it was overrun by the US Third Army. Note that the port main wheel tyres have been shot out by American troops to prevent unauthorised flights.

and inexperienced day-fighter pilots to the targets selected for the Luftwaffe's last great gamble: the New Year's Day attack on Allied airfields in the Low Countries. For the rest, it was business as usual, if such a term could be used to describe the chaotic conditions then prevailing. Crippled by lack of fuel, most aircraft were anchored firmly to the ground, elaborately camouflaged against Allied fighter-bomber attack. Only the most experienced crews remained fully operational. In January 1945 over 1,000 sorties were flown and 117 victories claimed. Impressive as these figures sound, they were mere pin-pricks against the massed might now wielded by Bomber Command.

The raid on Dresden on the night of 13/14 February encountered little aerial opposition; the few night-fighters aloft chased from one beacon to another without making proper contact with the bomber stream. Certain individual scores rose dramatically in other engagements during these closing weeks. In the early hours of 21 February, Major Heinz-Wolfgang Schnaufer – by now Kommodore of NJG 4 and the most highly-decorated and most successful night-fighter pilot of all – downed a pair of Lancasters. That same evening he added seven more in just 17 minutes. During the night of 21/22 February, I./NJG 6's Oberfeldwebel Günther Bahr claimed seven four-engined bombers, and Oberleutnant Johannes Hager of II./NJG 1 and Hauptmann Heinz Rökker of I./NJG 2 each downed six. The following month, on the night of 14/15 March 1945, Hauptmann Martin Becker, Gruppenkommandeur of IV./NJG 6, was responsible for exactly half the 18 Lancasters lost during a raid on a synthetic oil refinery near Merseburg; three of the nine bombers fell to his rear gunner, Leutnant Karl-Ludwig Johannsen.

However, these successes were just the dying gasps of an otherwise spent force – as, indeed, had been Operation Gisela, launched on the night of 13/14 March. Only weeks before the final surrender, this was a return to the intruder-type operations flown over the UK in 1940-41, but on a much larger scale. Nearly 150 Ju 88s crossed the North Sea to attack Bomber Command over its own bases. Twenty RAF aircraft were shot down. It was a defiant gesture, but otherwise achieved little more than to emphasise the opportunities missed when Hitler ordered the abandonment of the original intruder campaign late in 1941.

Surrender

The first Nachtjagdgruppen had been disbanded in February. The remainder, many reduced to single-Staffel strength, met their ends in various ways. After flying its last missions – night ground-attack sorties against 21st Army Group bridgeheads across the Lower Rhine – NJG 1 surrendered to British forces in Schleswig-Holstein. To the south, pilots of II./NJG 2 recaptured air superiority for a few glorious minutes by shooting up a US Army convoy on the Eisenach-Jena Autobahn before landing at Pocking and blowing up their aircraft. The Me 262 jets of Kommando Welter, redesignated 10./NJG 11 on 28 February 1945, used the Hamburg-Lübeck Autobahn as a landing strip for their last few operations before surrender to the British. NJG 5 flew both day and night ground-attack missions against the Soviets and in the Berlin region during the final weeks. Ground crews and other supernumerary personnel of many units ended the war as ground troops, from NJG 6 in Bavaria to the trainees of NJG 102 in Denmark.

The closing paragraph of the last order issued by Heinz-Wolfgang Schnaufer to his Geschwader on 8 May 1945 read: "When you are facing the difficult times to come in a different Germany, each of you, my men of NJG 4, can carry within you the certain conviction that you did everything humanly possible to win this war for Germany." It would seem a fitting epitaph for the entire Nachtjagdwaffe.

John Weal

The end in the south: Ju 88Gs share a hangar at Manching, southern Germany with an Arado Ar 234, a Bücker Bü 181 Bestmann and a pair of Allied Jeeps. Note the Ju 88G at the back of the hangar, its tail having been painted to resemble that of an earlier Ju 88C.

Junkers Ju 88G-6c
10./NJG 6
Bad Aibling
May 1945

Though it carried the 'W' code letter of 12. Staffel, '2Z+EW' was actually operated by 10./NJG 6, by May 1945 mainly engaged in *Nachtschlacht* (night ground attack). The unit had begun to switch to this role in late 1944 for the Lorraine campaign and action over the Ardennes. A few seasoned veterans continued to fly interception sorties against RAF bomber streams until the end of the war, but shortages of trained aircrew and fuel made their efforts fairly ineffective.

Jumo 213E engines
The Ju 88G-6c differed from the G-6b in being powered by a pair of 1,725-hp (1286-kW) Junkers Jumo 213E liquid-cooled inline engines in place of BMW 801G radials. These drove three-bladed, wooden VS111 propellers and, in addition, provided 237 lb (1.05 kN) of thrust at take-off.

Crew
There was sufficient space in the comparatively large Ju 88G-6 for four crew: pilot, observer/navigator, wireless/radar operator and gunner/observer.

Performance
With engine exhaust flame dampers fitted, the Ju 88G-6c's top speed ranged between 271 mph (436 km/h) at sea level and 331 mph (533 km/h) at 19,700 ft (6004 m).

Camouflage variation
For the *Nachtschlacht* role, the underside of this Ju 88G-6 has been repainted black for better concealment at low altitude; otherwise, it is finished in standard mottled night-fighter camouflage.

FuG 350 Naxos ZR
The transparent fairing above the cockpit housed this homing device manufactured by Telefunken. Intended to pick up Allied H_2S and centimetric AI transmissions, Naxos gave a bearing only, rather than an altitude and range, out to about 30 miles (48 km). In this aircraft the Naxos ZR variant was fitted, utilising the Lichtenstein SN-2d's tail-mounted, rear-warning antenna.

Armament
Gun armament consisted of six 20-mm MG 151/20 cannon, four in a tray (or *Waffentropfen*) under the centre-section and two in a *schräge Musik* installation in the rear fuselage. In later production Ju 88G-6cs, it was moved to a position just aft of the cockpit, causing a centre-of-gravity change which in turn resulted in a reduction in aft fuselage fuel tank capacity and, consequently, endurance by about 30 minutes.

Ju 188 tail surfaces
To improve lateral and longitudinal stability, the Ju 88G was built with a considerably enlarged tailplane and fin, akin to the type fitted to the Ju 188. Presumably in an attempt to confuse Allied aircrews, the tailfin was partially painted black to leave the outline of an earlier Ju 88C.

FuG 220 SN-2d
Characterised by the 45° angle at which its antenna dipoles were mounted, Lichtenstein SN-2d was the last incarnation of the FuG 220 system to see service and included a tail warning antenna, mounted under the aircraft's rudder.

Variant Briefing

Gloster Meteor

Part Two: Post-war development – PR.Mk 5 to U.Mk 21A

With its lead in the field of jet aircraft production over manufacturers like de Havilland, Gloster Aircraft continued to develop the Meteor after World War II, at the behest of the RAF. Increases in the power developed by its Rolls-Royce engines were exploited and new roles were assigned to the aircraft, including training, attack, reconnaissance and, latterly, night-fighting.

The Meteor's final military role in the UK has been with what is now known as the Defence Test & Evaluation Organisation (DTEO) at their facility in Llanbedr, Wales. Converted from an F.Mk 8, D.Mk 16 drone WH453/'L' was one of the last two airworthy examples when photographed in the 1980s. Placed in storage in the early 1990s, it left only WK800 in DTEO service, as a manned trainer and trials aircraft.

Although it lacked the swept wings and all-flying slab tails becoming *de rigueur* in the post-war US jet fighters, the Meteor remained in production until 1955, and the peak production rate was reached in 1951 (792 aircraft), long after many had written off the aircraft as obsolete. Production totalled 3,545 aircraft over the 12 years from 1944, and many more were built in the last six years than had been constructed in the first six. It was the F.Mk 8 (the last single-seat pure fighter version) that was the most widely built of the Meteor variants. Some pointed to the Meteor's combat record in Korea in the hands of the Australians as an example of its obsolescence, but this is probably unfair, and certainly over-simplified. The RAAF's pilots had no jet experience and converted straight to the Meteor from the Mustang, using the new jet in the same way, and thus failed to fully exploit its strengths and advantages. In any case, the Meteor spent most of the war as a fighter-bomber, not a fighter, proving effective in its primary role, and was among the more successful MiG-killing fighter-bomber aircraft used in the war.

NF.Mk 13s in action

Despite its age, the Meteor remained a remarkably effective fighter aircraft for many years, as the RAF had discovered during the 1956 Suez operation. An Egyptian NF.Mk 13 intercepted the Valiant flown by Group Captain (later Air Marshal Sir Lewis) Hodges, forcing him to take evasive action, while a Syrian Meteor (not a MiG-15 as has often been claimed) managed to claw down a Canberra PR.Mk 7 over the Lebanon. At least one Israeli

The Meteor was the first fighter design (other than the licence-built Hawker aircraft) built for the RAF by Gloster since the Gladiator. In need of a replacement for the Meteor, the Air Ministry looked to the same company. The ensuing programme produced the Javelin.

Meteor NF.Mk 13 also chalked up a victory during the brief but bloody campaign, downing an Egyptian Il-14 transport.

The Meteor served in the night-fighter and tactical reconnaissance roles with the RAF overseas, but disappeared from units in the Middle East in 1958, and from RAF Germany in 1960 upon the re-equipment of Nos 5 and 11 Squadrons. The Meteor remained in front-line service in the Far East for slightly longer. Meteor PR.Mk 10s assumed the tactical reconnaissance role from Mosquito PR.Mk 34s and Spitfire PR.Mk 19s during the mid-1950s. No. 81 Squadron received its first PR.Mk 10s in 1953, and flew its last Spitfire and Mosquito sorties on 1 April 1954 and 15 December 1955, respectively. The squadron then began to slowly re-equip with Canberra PR.Mk 7s from 1958, but the last Meteors remained in use for some years alongside the new Canberras. The last Meteor 'Firedog' sortie was flown in July 1961, and the final pair of aircraft was then ferried to Seletar for disposal.

Last front-line examples

Another Meteor squadron in the Far East Air Force was No. 60, which converted to all-weather Meteor NF.Mk 14s from Venom FB.Mk 4 fighter-bombers in October 1959. The squadron became the RAF's last front-line unit to use the aircraft in a front-line role, retiring its last aircraft in September 1961. They were not the last Meteors in service with a front-line unit, however, an honour that fell to the Akrotiri-based No. 29 Squadron, a Javelin unit which maintained its own target facilities flight with two Meteor F.Mk 8s and a single T.Mk 7. These aircraft were withdrawn from use and flown home in November 1965.

Although that marked the end of the Meteor in any kind of front-line RAF service, the type lingered on in second-line roles. In the training role, the Meteor had already virtually disappeared, with those Meteors 'kept on' for training long-legged pilots having been replaced by Hunters as the Gnat entered service. In the navigator training role, No. 1 ANS at Stradishall finally replaced its NF(T).Mk 14s in late 1965, when they were supplanted by Dominies. Small numbers of Meteors served with the Strubby-based Refresher Flying School within the RAF Flying College, later the College of Air Warfare, and remained active well into the 1960s (until at least 1967). The much-reduced need for Meteor QFIs and Standardisation allowed the Central Flying School to reduce its Meteor holding to a single T.Mk 7, which eventually formed the basis of the 'Vintage Pair' display team, with a Vampire T.Mk 11. In other roles, Meteors remained active: TT.Mk 20 target tugs served in relatively large numbers with a number of Royal Navy units, with No. 3/4 CAACU at Exeter, and with No. 1574 Flight in Singapore until 1970. F.Mk 8s also augmented Canberras with No. 85 Squadron in the target facilities role until 1970.

Overseas, it was a similar story, with a number of operators using Meteors into the early 1970s. In Argentina, the type lasted until 1971, while Brazil retired its last F.Mk 8s in 1974. The last of Ecuador's second-hand FR.Mk 9s clocked up 23 years of front-line service, retiring in 1977. This also represented 33 years in front-line service for the Meteor overall, a remarkable achievement at the time for a first-generation jet; a 33-year front-line career (or a 23-year front-line life with a single operator) is today routine, and has been comfortably

Top: The most numerous of all the Meteor variants, the F.Mk 8 was also in production for the greatest length of time, though only as an interim aircraft pending the arrival of new swept-wing fighters of the Swift and Hunter families.

Above right: The RAF's first jet trainer, the T.Mk 7, was ordered to fill an urgent need for a suitable conversion trainer with which to introduce RAF pilots to jet-powered flight. WL364 was, for a time, Gloster's official photographic aircraft.

Right: Something of a 'hot rod' among Meteors, Sa.2 Sapphire-engined WA820 had over twice the installed thrust (7,600 lb/33.8 kN) of a Derwent-engined production Meteor F.Mk 8 (3,500 lb/15.57-kN). With by Flt Lt Rob Prickett aboard, '820 set an FAI time-to-height record on 31 August 1951. It reached 12000 m in 3 mins 9½ secs.

The export successes scored by the Meteor Mk 4 were consolidated by the post-war variants. The Mk 8 and night-fighter variants found eager buyers, most of which also took the two-seat Mk 7 for conversion training. After spells in front-line service, a number of aircraft found employment as trials aircraft in both the UK and abroad. Ejection seat manufacturer Martin-Baker operated a number of aircraft with which it tested new 'bang seat' designs. One of the company's two complete 'T.Mk 7½' aircraft (WL419, seen here, being the example in use in early 1999) is likely to be the last Meteor to serve in a military capacity. Its simple construction and economy of operation ensure continued use by M-B.

exceeded by a large number of types.

Even after the last 'all-Meteor' units and front-line Meteors disappeared, significant numbers flew on as hacks and as test or trials aircraft, especially in Britain. The ETPS retired its last Meteor in 1965, the A&AEE retired its last Meteor in the late 1960s, and RAE Farnborough lost its last Meteor T.Mk 7 (XF274) in a take-off accident on 14 February 1975. The RAE at Bedford used the former Pershore-based NF.Mk 11 WD790 from 1978 until 1982. Two Meteors (a T.Mk 7 and an F.Mk 8) soldiered on as target tugs with No. 1 TWU at Brawdy until October 1982. The retirement of the latter three aircraft was prompted by a need for Meteor spares to keep the 'Vintage Pair' flying. The CFS 'Vintage Pair' operated until 25 May 1986, when a tragic collision at the Mildenhall air show destroyed the Meteor (WA669) and the Vampire. The 'spare' Meteor (WF791) continued to give displays until 1988, when it, too, was lost in a fatal accident at Coventry airport. Although on charge with the Central Flying School, the 'Vintage Pair' aircraft were, by then, display aircraft pure and simple.

Martin-Baker and Llanbedr

Elsewhere, a handful of Meteors remained active fulfilling more utilitarian purposes. At Llanbedr, the Meteor population at the beginning of the 1970s stabilised at three U.Mk 16 target drones, together with a T.Mk 7 and an NF.Mk 11 for photo chase and hack duties. The latter two aircraft were replaced by early BAe Hawks in 1989 and 1978, respectively, with the NF.Mk 11 going to RAE Bedford and the T.Mk 7 to Martin-Baker at Chalgrove, for spares. The drones were reduced to two after 15 August 1979, when WH320 was expended in trials of the SkyFlash missile. One remains active to this day (with the other in store), training drone controllers and usually flying manned. At Chalgrove, Martin-Baker continues to fly one of its two long-term T.Mk 7s for ejection seat trials, flying often, but usually for very short five- or 10-minute sorties, averaging only 24 hours per annum. The aircraft has ample airframe life remaining, and, with its simple systems and manual non-boosted controls, is cheaper and simpler to maintain than would be a modern replacement like a Hawk. There is every likelihood that this Meteor (or M-B's other Mk 7) will serve on into the new millennium, a fitting end for what was the world's first practical jet fighter. There are also a handful of privately owned Meteors – warbirds flown for pleasure and on the air show circuit – which may remain airworthy for many years.

Jon Lake

***Above:** Built by Armstrong Whitworth, the two-seat Mk 14 night-fighter was the ultimate production Meteor variant. Derived (via Mks 11, 12 and 13) from the early Mk 8 day fighter, with its comparatively small Derwent engines, the Mk 14 suffered speed and range deficiencies accordingly.*

***Right:** The RAAF took its Mk 8s to war in Korea in 1951. In most respects, apart from turning radius, they were outclassed by the swept-wing fighters of the day, but found employment in the attack role, often armed with rockets.*

Gloster Meteor Variants

Meteor PR.Mk 5 (G.41H)

The Meteor's potential in the photo-reconnaissance role was demonstrated from an early date, and in July 1945 several F.Mk IIIs were allocated to No. 541 Squadron at Benson for evaluation. EE338 was used as an early reconnaissance prototype, replacing its cannon with two side/oblique cameras in the extreme nose. The aircraft had previously been a two-seater, used in support of ejection seat trials, and was returned to single-seat configuration for reconnaissance development. An F.Mk 4, RA418, also flew with a reconnaissance nose. The Meteor PR.Mk 5 was a one-off reconnaissance conversion from F.Mk 4 VT347, with two F.36 vertical cameras in the rear fuselage, and a single F.24 in the nose. The latter could be set on the ground for forward, left or right oblique photography, with three windows in the modified nose. The aircraft broke up during a high-speed run over Moreton Vallance during its first flight on 13 July 1949 (not 15 June, as has sometimes been reported). The later PR.Mk 10 was similar, but featured the more powerful engines, longer fuselage and increased fuel capacity of the F.Mk 8.

After a spell with Martin-Baker Ltd as a camera ship engaged in photographing ejection seat tests on EE416 (for which a seat for the photographer was added in the ammunition bay), EE338 was transferred to Farnborough for photo-reconnaissance trials. Here, the aircraft's camera ports may be clearly discerned.

F.Mk 6 (G.41J)

The projected F.Mk 6 remained unbuilt. It was reportedly similar to the F.Mk 8 (but with Derwent 7s in long nacelles), and was not (as sometimes reported at the time) a swept-wing version, although such versions were sketched by the design department, some receiving P.xxx-type project numbers. The so-called Meteor Development, for example, was essentially an aircraft like the later F.Mk 8 but with modestly swept tailplanes and a tapering delta wing with straight trailing edges and 20° of sweep on the leading edge. The greater wing chord forced the use of longer jetpipes (with consequently lower efficiency), but the design promised to raise the Meteor's maximum Mach number from 0.82 to 0.88, and the service ceiling from 47,000 to 54,000 ft (14325 to 16460 m).

Meteor T.Mk 7 (G.43)

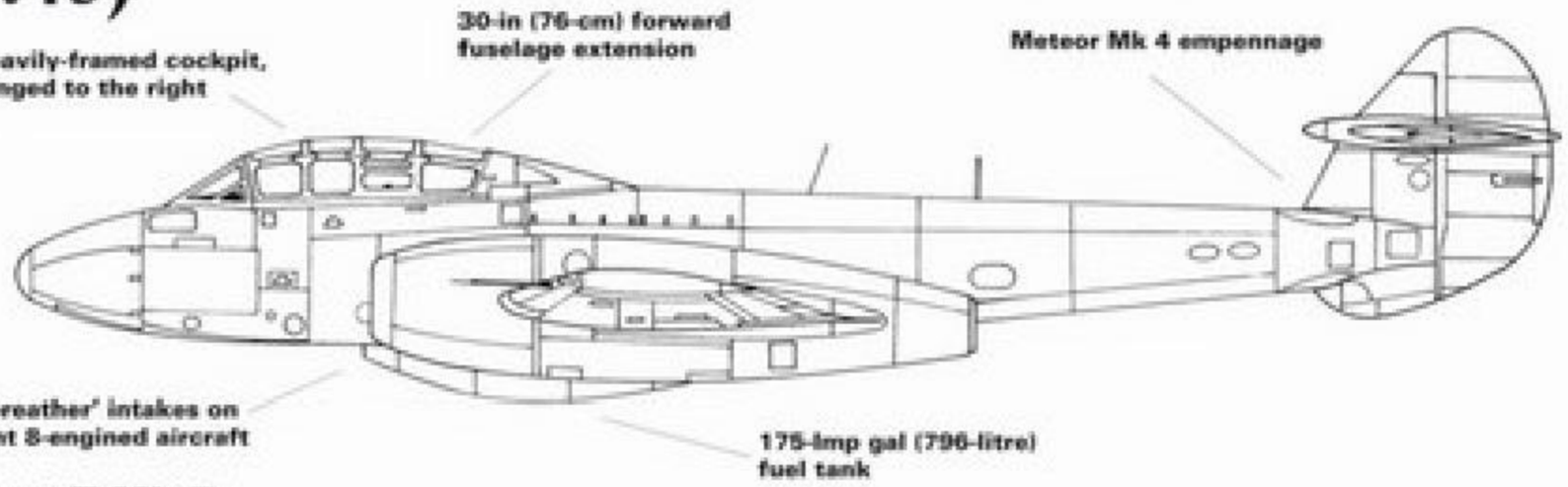
Two-seat conversions of F.Mk IIIs had been made for various purposes, but their rear cockpits tended to contain little more than a seat, and were not fitted with dual controls. Initially, the RAF saw no need for a two-seat trainer version of the aircraft. Pilots had converted to the Spitfire (which was, in truth, probably more difficult to fly) without recourse to a two-seat Spitfire, and it was initially thought that Meteor pilots would do the same. But an accident rate which had been acceptable in wartime was less easy to justify in peacetime, while the new jets brought their own handling quirks and unique operating procedures, and the experienced wartime generation of pilots began to be replaced by new young recruits and even National Servicemen. It gradually became clear that there was a need for a stepping stone between Advanced Flying Training on the Harvard and front-line service with a Meteor squadron, and that such a stepping stone should be a jet, rather than an obsolete Spitfire. Initially, though, the very pace of jet fighter development provided its own solution to the problem, and when the Meteor F.Mk Is and early Welland-engined IIIs gave way to later aircraft they were assigned to No. 1335 Conversion Unit at Molesworth. This subsequently combined with No. 61 OTU to form No. 226 OCU at Bentwaters, later moving to Stradishall.

The idea of having a dedicated two-seat Meteor trainer may never have occurred to the RAF, had such an aircraft not already been developed by Gloster as a private venture. This aircraft was built primarily as a demonstrator, following the loss of the company's F.Mk 4 demonstrator, G-AIDC, when a Belgian pilot crash-landed. Had one of Gloster's own test pilots been in the back seat, it was felt, the aircraft might have been saved, and the decision was taken that, in future, the company's aircraft would always be flown under the supervision of a Gloster pilot. If customers and potential customers were ever to fly the aircraft, this meant that a two-seat demonstrator would be required. Accordingly, the remains of G-AIDC were rebuilt as a two-seater, with a new forward fuselage 30 in (76 cm) longer, and with tandem cockpits covered by a heavily-framed, sideways-hinging canopy. The lengthened forward fuselage improved directional stability and freed the aircraft from having to carry ballast in the nosewheel bays or in the form of heavy alloy intake lips. As G-AKPK, the rebuilt aircraft made its maiden flight on 19 March 1948, with Bill Waterton at the controls.

Gloster was optimistic that the two-seat Meteor would attract some production orders (though there was still no RAF requirement for such an aircraft), not least from air forces whose training philosophy was different, or in whose inventory the Meteor would mark a major step in performance from other types. The potential usefulness of a two-seat trainer was underlined when the first Argentine pilots underwent conversion at Moreton Vallance: they initially taxied around the airfield, canopies removed, and with anxious instructors perched precariously on the aircraft spine, shouting instructions!

Once G-AKPK was being used for demonstrations, the Gloster marketers found themselves being asked whether they could supply similar aircraft to customers for the Meteor F.Mk 4; the RAF also took note of the aircraft, and ordered it as an advanced jet lead-in trainer. After a brief sales tour the demonstrator itself was sold to the Royal Netherlands Air Force as I-1 in November 1948 but, by then, production of the aircraft for the RAF, as the T.Mk 7, had begun. The first example had made its maiden flight on 26 October 1948.

The suddenness with which the Meteor T.Mk 7 found itself in demand meant that it


heavily-framed cockpit, hinged to the right
30-in (76-cm) forward fuselage extension
Meteor Mk 4 empennage
'deep breather' intakes on Derwent 8-engined aircraft
175-Imp gal (796-litre) fuel tank

Meteor T.Mk 7

Left: Illustrating the T.Mk 7's planform, WA669 was one of the RAF's last T.Mk 7s, maintained as part of the 'Vintage Pair' Vampire T.Mk 11/Meteor T.Mk 7 display team.

Below: With its air brakes deployed, T.Mk 7 WL415 displays the so-called 'deep breather' engine air intakes associated with Derwent 8 engines. WL415 was delivered to the Belgian air force as ED-10.

Gloster Meteor Variants

Above: One of at least two Meteor Mk 4s converted to Mk 7 standard, EE530, seen here with an anti-spin parachute fitted, started life (as a Mk 4) with the RAF High Speed Flight. Post-conversion, it was allocated to RAE Farnborough for trials.

Above: The Meteor Mk 7 was the mainstay of the RAF Flying Training Command from 1949 until the mid-1950s. These aircraft were on the strength of No. 203 Advanced Flying School at RAF Driffield, which began the first jet conversion course with Meteors in August.

The Royal Navy operated a small fleet of T.Mk 7s, mainly in the training and fleet requirements roles. This quartet was with No. 728 Sqn (the FRU based at Hal Far, hence the 'HF' tailcodes) in the late 1950s/early 1960s. Though never operated from carriers, a Mk 7 made a series of 'touch-and-go' aboard landings aboard HMS Ark Royal in 1955.

was developed quickly, and perhaps without sufficient thought given to the aircraft's role and requirements. Thus the T.Mk 7, intended as an advanced fighter trainer, had no cannon, and no provision for bomb or rocket armament. Similarly, though the aircraft might be used to train pilots with no previous jet experience, the instructor's cockpit contained no fuel gauges, engine temperature indicators or relight buttons and, although capable of reaching 50,000 ft (15240 m), the T.Mk 7 was completely unpressurised. Some of these omissions were remedied later in the T.Mk 7's service life. One major problem was that the extended forward fuselage required a commensurate increase in fin and rudder area, and that this was never provided as standard. A Meteor F.Mk 4, RA382, had already flown with the larger tail unit of the experimental E.1/44, and this was adopted for the production F.Mk 8, whose prototype flew only a few months after G-AKPK emerged as the first two-seater. Common sense should have dictated that all two-seaters would use this new tail, but apart from a handful of so-called 'Meteor 7½s', this did not happen. Moreover, in the age of the F-86 Sabre, the Meteor T.Mk 7's heavily framed canopy was a ridiculous anachronism. Remarkably, a clear-view 'blown' canopy did not appear on a production two-seater until the arrival of the NF.Mk 14, and the trainer versions never received one.

Some 640 T.Mk 7s were built for the Ministry of Supply, including 43 planned for service with the Royal Navy, and the last of the British-serialled trainers (XF278, delivered after its sister, XF279) was delivered on 27 July 1954.

The RAF-serialled T.Mk 7s were VW410-459, VW470-489, and VZ629-649 to Contract No. 6/ACFT/1389 C.B.7(b), WA590-639, WA649-698, WA707-743 to Contract No. 6/ACFT/2982 C.B.7(b), WF766-795, WF813-862, WF875-883 to Contract No. 6/ACFT/5044 C.B.7(b), WG935-950, WG961-999, WH112-136, WH164-209, WH215-248 to Contract No. 6/ACFT/5621 C.B.7(b), WL332-381, WL397-436, WL453-488, WN309-321 to Contract No. 6/ACFT/6066 C.B.7(b), WS103-117 to Contract No. 6/ACFT/6410 C.B.7(b) for the Royal Navy, and WS140-151 and XF273-XF279 to Contract No. 6/ACFT/6411 C.B.7(b). Of these, the Royal Navy aircraft included VW417(?), VZ645-648, WA600, WA652, WL332-337, WL350-353, WL366 (?), and WS103-117. From VZ639, the T.Mk 7s incorporated a Meteor F.Mk 8-type nosewheel bulkhead, with an improved undercarriage retraction system.

Meteor T.Mk 7s were delivered to dedicated training units – Advanced Flying Schools which bridged the gap between FTS and OCU, Operational Conversion Units, and later the advanced Flying Training Schools themselves, as well as smaller, more specialised units. The T.Mk 7s were also delivered in ones and twos to front-line squadrons as hacks and for continuation and instrument training. They did not go just to Meteor squadrons: before the widespread availability of Vampire T.Mk 11s, Meteor trainers were supplied to Vampire, Venom and Sabre squadrons, and some continued in use long enough to serve with squadrons equipped with the Javelin. A handful were even used by Canberra squadrons, especially overseas.

More T.Mk 7s were produced through the conversion of F.Mk 4s, including EE530, EE573 and a number of export aircraft. Surplus ex-RAF Meteor T.Mk 7s were delivered to a number of export customers, and some aircraft built to RAF contracts were diverted to overseas customers.

Australia took nine T.Mk 7s, serialled A77-2, -4, -229 (later -701), -305 (later -702), -380 (later -703), -577 (later -704), -705, -706, and -707. These were ex-VW410, WN321, WA731, WA732, WG974, WG977, WA680, WF843 and WH118. Belgium's initial batch of Meteor T.Mk 7s included nine diverted from RAF orders, comprising WF817, WF818, WF827, WH171, WH174, WL399, WL415, WL427 and WL428 (respectively serialled ED-4, ED-6, ED-5, ED-11, ED-12, ED-7, ED-10, ED-9, and ED-8). Subsequently they were joined by WA684, WA688, WF814, WG970, WH114, WH117, WL486, WN320, WS140, WS141 and XF273 (ED-40, ED-38, ED-43, ED-42, ED-39, ED-41, ED-33, ED-34, ED-35, ED-36 and ED-37 in Belgian service). Brazil's 10 Meteor T.Mk 7s (4300-4309) were previously WS142 to WS151, but were never delivered to the RAF. The last three Egyptian T.Mk 7s (1439-1441), of six delivered, were ex-RAF aircraft, WA730, VW435 and WG994. France took delivery of two embargoed Syrian T.Mk 7s and followed them with 10 ex-RAF aircraft, while another was delivered to SNCASO as an ejection seat testbed. The ex-RAF aircraft were WF776, WF832, WG997, WH136, WH168, WH228, WL425, WL471, WL476 and WN312, and possibly one more. Serial tie-ups are not known, though the French serial block ran from F1 to F11. The aircraft were used mainly by Escadre de Chasse 30, for training Meteor NF.Mk 13 aircrew. The French ejection seat test aircraft was F-BEAR, ex-WA607, converted by Flight Refuelling.

Israel's Meteor T.Mk 7s included two ex-RAF aircraft, WL434 and WL466 (serialled 17 and 18, later 111 and 112, and eventually 2170 and 2171, respectively). The Netherlands was the largest overseas customer for the Meteor, and its order included 45 T.Mk 7s, one of them G-AKPK, the prototype, and 38 ex-RAF aircraft. The ex-RAF aircraft were VW417, WA592, WA623, WA626, WA633, WA674, WF856, WG998, WH126, WH135, WH165, WH177, WH179, WH193, WH196, WH199, WH202, WH203, WH207, WH222, WH227, WH233, WH245, WH247, WL412, WL426, WL469, WL477, WL482, WL487, WN315, XF275, XF276, XF277, XF278, and XF279, respectively serialled I-320, I-322, I-8, I-9, I-10, I-319, I-323, I-304, I-305, I-316, I-11, I-325, I-16, I-13, I-14, I-15, I-17, I-12, I-301, I-302, I-308, I-19, I-310, I-324, I-318, I-306, I-18, I-309, I-20, I-303, I-307, I-317, I-311, I-312, I-314, I-313. Previous identities for I-315 and I-321 are unknown. The Dutch two-seat Meteors served with the operational Meteor squadrons (Nos 322, 323, 324, 325, 326, 327 and 328), with the fighter squadron at Twenthe (and later Woensdrecht) and briefly during 1955-56 with Nos 700 and 701 Squadrons as they re-equipped with F-86D Sabres.

Two ex-RAF Meteor T.Mk 7s were delivered to Sweden as target tugs for the Svenske Flygtjänsk in 1955. Formerly WF833 and WH128, they were registered SE-CAS and SE-CAT. SE-CAT was destroyed on 21 January 1959 and was replaced by SE-DCC, the former Reaper and two-seat demonstrator G-ANSO. The aircraft had been ordered in November 1958, and was delivered on 11 August 1959. Two T.Mk 7s intended for the RAF (WL471 and 472) were delivered to Syria as 91 and 92, replacing two earlier aircraft built for Syria, halted by embargo, and diverted to France. Two RAF Meteor T.Mk 7s (WA740 and WA742) were also briefly used by No. 421 Squadron, RCAF, while that unit was based at RAF Odiham, equipped mainly with single-seat de Havilland Vampire F.Mk

The second production Mk 7, VW411, spent its entire life as a trials airframe, operated at one time or another by all the major experimental research establishments. Involved in the Meteor drone programme and the development of an automatic airbrake, '411 was eventually fitted with a Mk 8 rear fuselage and a PR-type camera nose, the side camera ports of which were blanked out. Finished in Royal Blue overall in 1966, the aircraft was passed to the Proof and Experimental Establishment, Pershore, where it finished its days, possibly as a target.

WA634 was one of the first Meteor equipped with an E.1/44-type tail of the sort that became standard on the Meteor Mk 8.

3s. Another two (WH220 and WH238) were used by RAAF Vampire squadrons while they were based on Malta during 1952-55.

Some T.Mk 7s allocated to Station Flights and to front-line squadrons and other units were modified with target-towing lugs on the centreline, allowing them to tow a banner or drogue target. Some even received black-and-yellow-striped undersides for the target-towing role. Their unofficial designation was TT.Mk 7 or T(TT).Mk 7. Examples included WA659, WA721, WA725, WF772, WL349, WL468 and WN309. Damaged RAF T.Mk 7s WF633 and WH128 were repaired by Flight Refuelling Ltd and converted to target-tug configuration for export to Sweden as SE-CAT and SE-CAS.

Some Royal Navy T.Mk 7s, used by the Fleet Requirements Unit in the silent-target role, were fitted with nose-mounted Harley lights to increase conspicuity 'head-on'. These included WL332, WL353 and WS103.

Rebuilt from the remains of Meteor Mk 4 G-AIDC, the Mk 7 prototype and company demonstrator G-AKPK was finished in carmine red with the legend* GLOSTER METEOR MK VII ROLLS ROYCE DERWENT V ENGINES *on its flanks. It was delivered to the RNethAF in 1948.

Export Meteor T.Mk 7

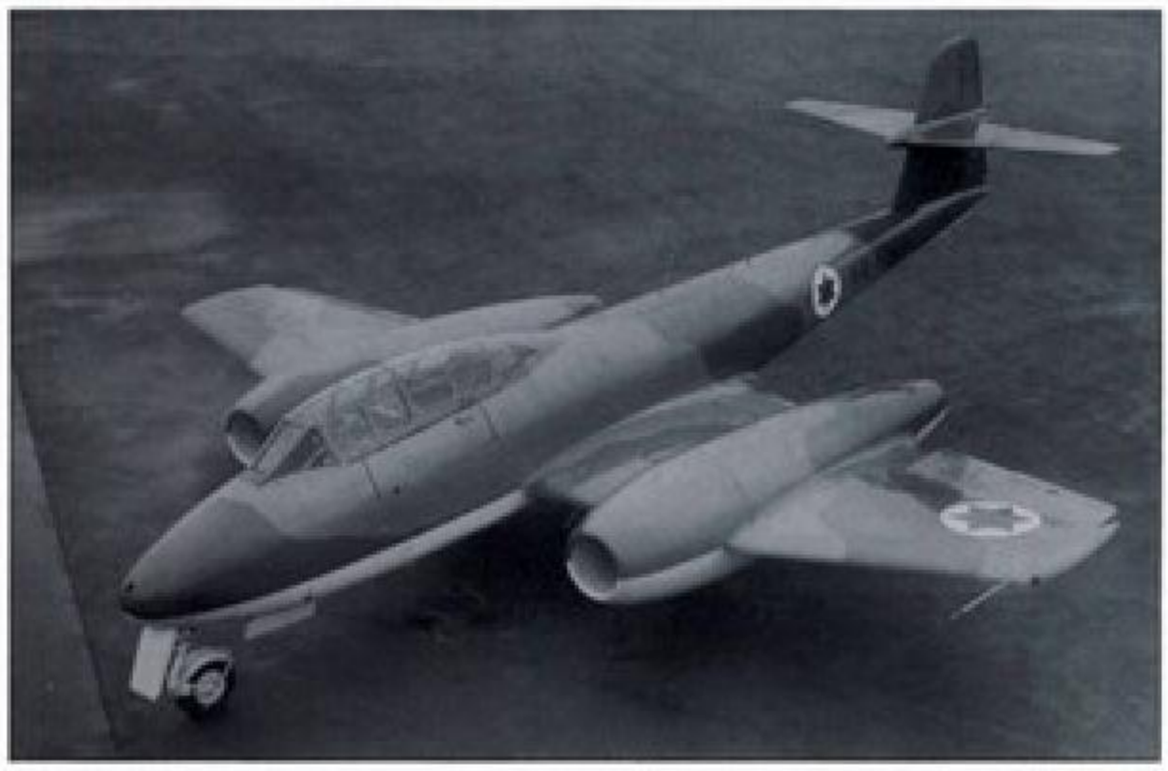
A large number of the Meteor T.Mk 7s delivered to overseas customers were never allocated RAF serials, though even those which did were sometimes delivered straight from the production line, without seeing RAF service. For instance, although Brazil's Meteor T.Mk 7s (FAB serials 4300-4309) had RAF serials WS142-151, they were believed to have been allocated to Brazil while still on the production line. Brazil's Meteors were fitted with a radio compass, like the country's F.Mk 8 fighters. Other customers took a mix of 'new-build' T.Mk 7s and aircraft which had been allocated RAF serials, or even aircraft which had seen RAF service. Some took delivery of aircraft converted from their own F.Mk 4s. Most of the overseas twin-stickers were equivalent to later RAF T.Mk 7s, with 3,600-lb st (16.0-kN) Derwent 8 engines and the larger-diameter 'deep breather' engine intakes.

Belgium's 43 Meteor T.Mk 7s included 20 RAF-serialled aircraft, as detailed above (ED-4 to ED-12 and ED-33 to ED-43). They augmented three new-build aircraft (ED-1 to ED-3) and 20 aircraft produced by Avions Fairey using Gloster-supplied two-seat noses married to redundant F.Mk 4s. Serialled ED-13 to ED-32, these were respectively ex-EF-4, EF-7, EF-9, EF-10, EF-11, EF-12, EF-13, EF-15, EF-16, EF-18, EF-19, EF-21, EF-23, EF-25, EF-28, EF-30, EF-32, EF-39, EF-41 and EF-42. A handful of Belgian air force T.Mk 7s were subsequently modified by Avions Fairey with F.Mk 8 tail units.

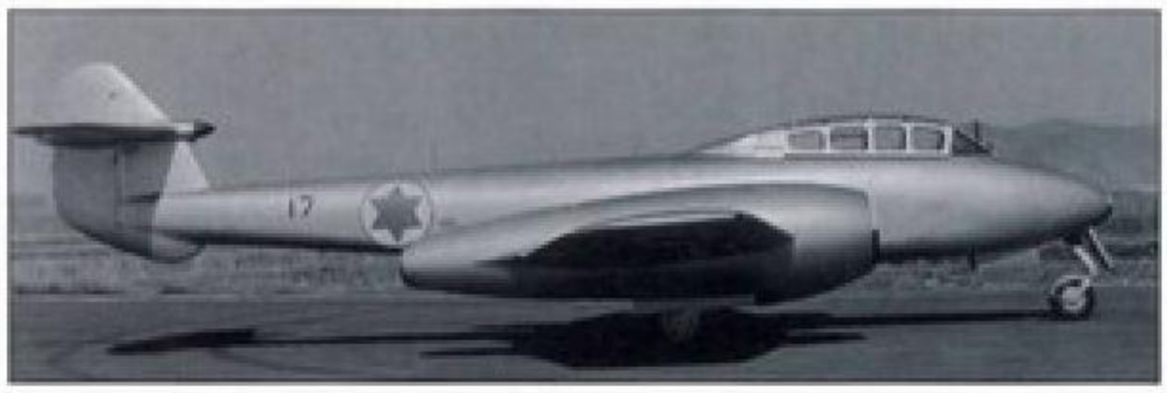
Denmark took nine T.Mk 7s (261-269), serving with the Naval OCU at Karup and then with No. 723 Squadron. Egypt's Meteor force included six T.Mk 7s (1400, 1413, 1414, and1439-1441), the first three being newly built. The first was delivered on 27 October 1949, and went on to serve with No. 4 Fighter Training Unit at Alexandria. France took delivery of two embargoed Syrian T.Mk 7s, but the rest of its T.Mk 7s were ex-RAF aircraft, as detailed above.

Israel's initial batch of eight Meteor F.Mk 8s also included four T.Mk 7s, serialled 13-16, and respectively named *Sufa*, *Sa'ar*, *Ra'am* and *Barak* (Storm, Assault, Thunder and Lightning). They were ordered on 10 February 1953. The first two T.Mk 7s (Israel's first jets) were delivered on 17 June 1953. All were fitted with ventral target-towing lugs. Two more ex-RAF aircraft (17 and 18, formerly WL434 and WL466) were delivered in March and October 1955. They were augmented by at least two, and probably four, ex-Belgian T.Mk 7s, two of which had F.Mk 8 tail units. One was delivered using the ferry registration 4X-FNB, and one (perhaps the same aircraft) became 21 in service. The Israeli Meteor T.Mk 7s initially served with No. 117 Squadron, whose primary role was to convert as many pilots as possible to jets, but which also initially functioned as a front-line fighter/ground attack squadron. After the 1956 war, No. 117 Squadron became the IDF/AF's advanced training/fighter lead-in unit, finally disbanding on 11 February 1962. The Meteors then served on with No. 107 Squadron 'Knights of the Orange Tail' (in the target-towing role) and three T.Mk 7s flew with the Vautour-equipped No. 110 Squadron. The latter were the last Meteors in Israeli service, retiring after a last formation flight by 15, 17 and 21 in 1970.

The Netherlands was the largest overseas customer for the Meteor, and it received 45 T.Mk 7s, including G-AKPK, the prototype, and 38 ex-RAF aircraft detailed in the preceding entry. At least 10 (I-4, I-9, I-14, I-18, I-304, I-305, I-306, I-309, I-312 and I-316) were subsequently transferred to the Marine Luchtvaart Dienst (Naval Air Arm) where they served with No. 3 Squadron.



Israel's T.Mk 7s were a mixed bag of ex-RAF and ex-Belgian aircraft. 4X-FNB (above) was one of the latter, fitted with an E.1/44 tail, while IDF/AF 17 (below) arrived from the RAF, with which it had been serialled WL434.



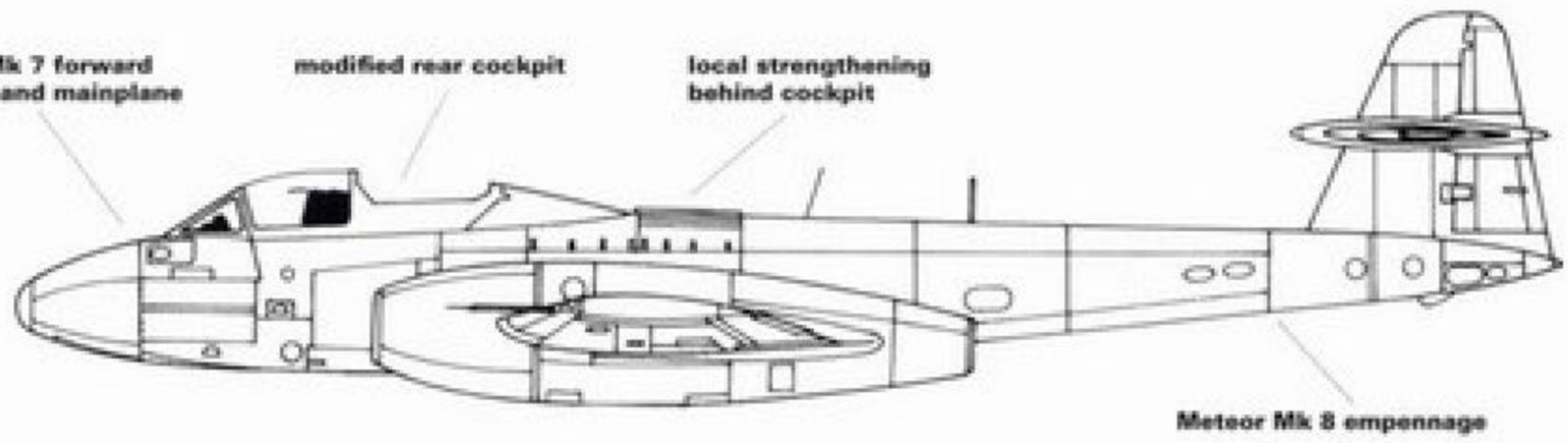
The aircraft were serialled from 131-140, though naval/air force serial tie-ups are known only from I-304 which became 21-50 and then 132, with the others following sequentially to I-316, which became 21-55 and then 137. The first two aircraft were used to familiarise the squadron's Sea Fury pilots with jets while it re-equipped with Armstrong Whitworth Sea Hawks in November 1957, there being no two-seat Sea Hawk variant. Eight more were taken on charge between October 1958 and April 1959, for routine training and as hacks. Six remained by the end of September, continuing in service until 3 July 1961, when the squadron disbanded, handing over its training commitment to the front-line No. 860 Squadron.

Syria ordered two T.Mk 7s as part of its 1950 order for Meteors, and these aircraft were completed, painted and even handed over to the Syrians on 10 June 1951 for training at Gloster's Moreton Valance airfield. They were subsequently 'confiscated' when an embargo was imposed and were diverted to meet a French order. Replacements, wearing the same serials (ex-RAF aircraft, WL471 and WL472, serialled 91 and 92), were delivered to Syria on 4 November 1951.

Belgian air force Meteor F.Mk 4 EF-30 was rebuilt by Avions Fairey as a T.Mk 7 and reserialled ED-28. Later, the same company further modified the aircraft by fitting a Mk 8-type tail.

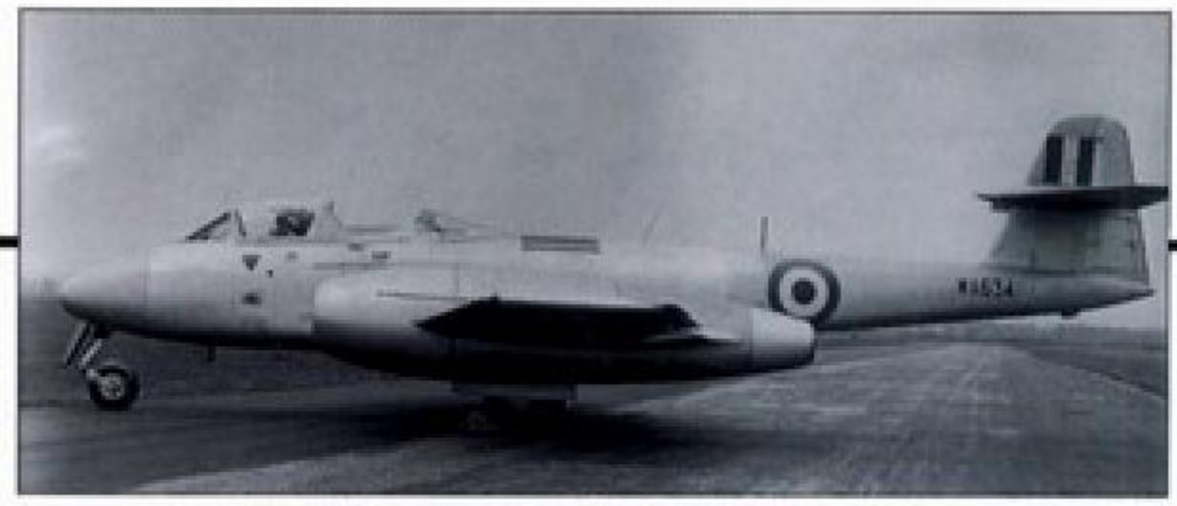
Meteor 'T.Mk 7½'

The unofficial designation Meteor T.Mk 7½ has been applied to a number of hybrid Meteors which combined features of the two-seat T.Mk 7 with features from other versions. They were usually T.Mk 7s with F.Mk 8 tail units. Examples included some Belgian T.Mk 7s, at least two of Israel's last four (ex-Belgian) two-seaters, WW413, and WW411 and WL375 used by the A & AEE. Even more famously, the square-tailed two-seaters included the modified Meteor T.Mk 7s used by Martin-Baker for ejection seat trials. They were also occasionally known as Meteor T.Mk 17s, although their official designation is believed to have been T.Mk 7(Mod). Martin-Baker has used three modified Meteors, with WA634 serving from August 1953 until April 1962, followed


Meteor Mk 7 forward fuselage and mainplane
modified rear cockpit
local strengthening behind cockpit
Meteor Mk 8 empennage

Meteor 'T.Mk 7½'

by WA638 which was grounded in 1979, when it was replaced by WL419, previously in use as a spares ship. The modifications to the aircraft included a clear-view canopy over the forward cockpit, with the rear cockpit open, but with a fairing behind. There were external strengthening strips behind the rear cockpit, atop the fuselage. The Meteor 7/1 designation was also applied to some Meteor T.Mk 7s with reconnaissance noses (Australian A77-701, WA690 and WL403, for instance) which retained a normal T.Mk 7 tail unit.



Top right: Sqn Ldr John Fifield OBE, DFC, AFC made the first live runway-level ejection in a Martin-Baker seat, at a speed of 90 kt (167 km/h) on 3 September 1955 in WA634. The aircraft then sported a cut-down T.Mk 7-type framed cockpit canopy, later replaced with a clear-view canopy, seen here.

Right: Another ejection seat under test is blasted from the rear cockpit of WL419. This aircraft started life as a standard T.Mk 7 allocated to No. 85 Sqn. After spells with No. 13 Group Communications Flight, Central Fighter Establishment and No. 233 OCU, it joined M-B. In service since 1979, it continued to serve with the company as a flying ejection seat testbed in 1999. The aircraft that '419 replaced, WA638, was grounded in 1979 but was retained by M-B, and in 1999 was undergoing a rebuild to flying status as an eventual replacement for WL419. T.Mk 7 WL405 is held by the company as a spares source.

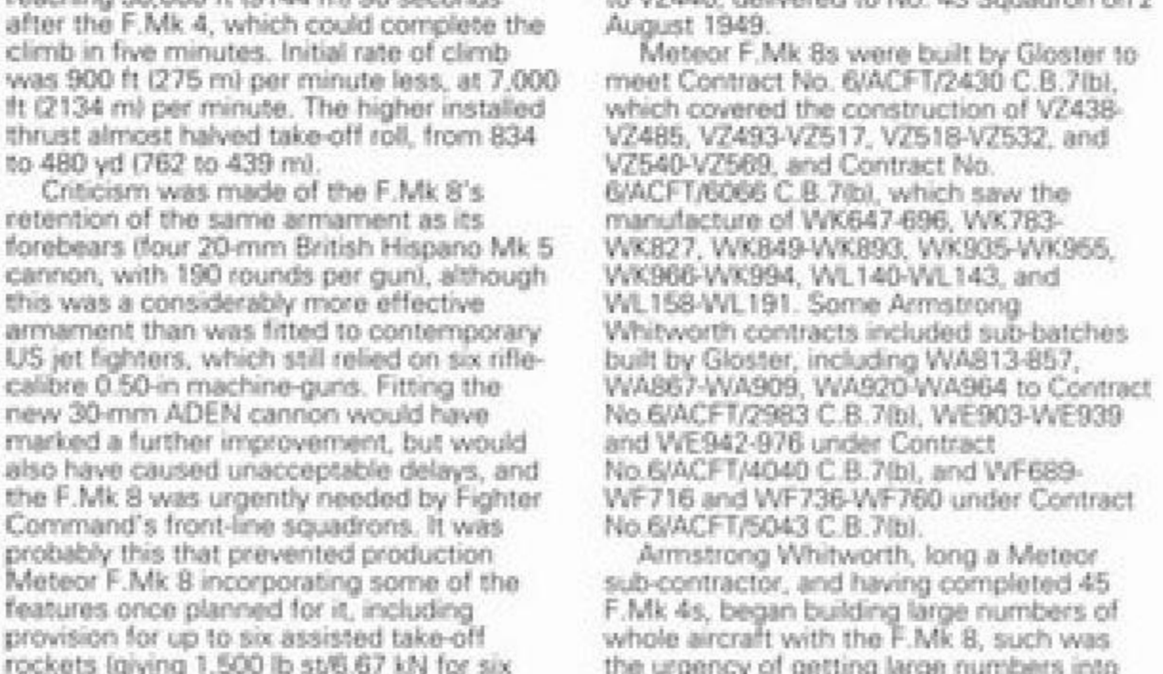
Meteor F.Mk 8 (G.41K)

The F.Mk 8 was built in larger numbers than any other version, and remained in production longer, yet was ordered as an interim fighter, bridging the gap between the obsolescent Meteor F.Mk 4 and the new-generation Hunter and Swift. When it became clear that the longer nose and forward fuselage of the T.Mk 7 improved the Meteor's directional stability, a single F.Mk 4 (RA382) was modified with a similar fuselage plug between the ammunition bay and the main tank. The new section accommodated a 95-Imp gal (430-litre) fuel tank, raising internal capacity from 325 to 420 Imp gal (1477 to 1910 litres). This was the configuration originally intended for the new Meteor fighter variant, the planned F.Mk 8, and the first 100 F.Mk 8s were reportedly ordered with the original tail unit.

The new tank (when full) and forward shift of the ammunition bay (containing 800 lb/363 kg of ammunition when full) moved the centre of gravity beyond acceptable limits and destabilised the aircraft in pitch. The solution was to fit a new tail unit, and RA382 was modified to accept a tail from one of the Gloster E.1/44 prototypes, flying in its new guise from February 1948. This made the aircraft broadly equivalent to the new F.Mk 8 as it was eventually built, at least in terms of external configuration.

The Meteor F.Mk 8 was much more than a modestly stretched F.Mk 4 with a new tail unit. It featured a Martin-Baker Mk 1 or Mk 1E ejection seat and was fitted with a retractable gyro gunsight, and had a new wingroot fillet. The Mk 1E featured automatic separation of the pilot from his seat. Some seats were later updated to Mk 2E standards, with a Duplex drogue allowing safe escape at heights as low as 125 ft (38 m). The two-piece cockpit canopy of the F.Mk 3 and F.Mk 4, wherein the middle section slid aft over a fixed transparent rear fairing, was replaced by a single-piece aft-sliding powered canopy incorporating a metal fairing. The various structural changes imposed an empty weight penalty of 126 lb (57 kg), taking the figure to 10,626 lb (4820 kg), but the aircraft weighed 15,700 lb (7122 kg) at operational weights, with internal fuel only, and could weigh as much as 19,100 lb (8664 kg) with full internal and external fuel, 4,000 lb (1814 kg) more than a heavily laden F.Mk 4.

Perhaps most importantly, it featured new 3,500-lb st (15.57-kN) Derwent 8 engines, the increased thrust necessitating the strengthening of some parts of the aircraft's structure. The 'heavyweight' F.Mk 8 also received a new, stronger undercarriage, taken from the NF.Mk 11 night-fighter. With a full operational load, the F.Mk 8 demonstrated a maximum level speed of 590 mph (950 km/h) (officially 592 mph; 958 km/h) at sea level, even before the aircraft entered service, and before the last refinements were made, which added a few extra knots. The production F.Mk 4 managed 585 mph (941 km/h) at low level, by way of comparison. Test pilots explored high Mach numbers in the early F.Mk 8s, though the limiting Mach number for service pilots was lower.



The first production Mk 8, VZ438, is seen here shortly after completion. Immediately noticeable are the E.1/44-type tail, Martin-Baker ejection seat and the original narrow engine air intakes.

With its cropped wings, the F.Mk 8 did not climb as well as the long-span F.Mk 4, reaching 30,000 ft (9144 m) 90 seconds after the F.Mk 4, which could complete the climb in five minutes. Initial rate of climb was 900 ft (275 m) per minute less, at 7,000 ft (2134 m) per minute. The higher installed thrust almost halved take-off roll, from 834 to 480 yd (762 to 439 m).

Criticism was made of the F.Mk 8's retention of the same armament as its forebears (four 20-mm British Hispano Mk 5 cannon, with 190 rounds per gun), although this was a considerably more effective armament than was fitted to contemporary US jet fighters, which still relied on six rifle-calibre 0.50-in machine-guns. Fitting the new 30-mm ADEN cannon would have marked a further improvement, but would also have caused unacceptable delays, and the F.Mk 8 was urgently needed by Fighter Command's front-line squadrons. It was probably this that prevented production Meteor F.Mk 8 incorporating some of the features once planned for it, including provision for up to six assisted take-off rockets (giving 1,500 lb st/6.67 kN for six seconds) and optional ventral gun packs.

The true F.Mk 8 prototype was another converted F.Mk 4, VT150, which flew for the first time on 12 October 1948, in the hands of Jan Zurakowski. The first production F.Mk 8, VZ438, was delivered to No.1 Squadron at Tangmere on 10 December 1949, though this was not the first front-line F.Mk 8. This distinction went to VZ440, delivered to No. 43 Squadron on 2 August 1949.

Meteor F.Mk 8s were built by Gloster to meet Contract No. 6/ACFT/2430 C.B.7(bl), which covered the construction of VZ438-VZ485, VZ493-VZ517, VZ518-VZ532, and VZ540-VZ569, and Contract No. 6/ACFT/6066 C.B.7(b), which saw the manufacture of WK647-696, WK783-WK827, WK849-WK893, WK905-WK955, WK966-WK994, WL140-WL143, and WL158-WL191. Some Armstrong Whitworth contracts included sub-batches built by Gloster, including WA813-857, WA867-WA909, WA920-WA964 to Contract No.6/ACFT/2983 C.B.7(bl), WE903-WE939 and WE942-976 under Contract No.6/ACFT/4040 C.B.7(bl), and WF689-WF716 and WF736-WF760 under Contract No.6/ACFT/5043 C.B.7(bl).

Armstrong Whitworth, long a Meteor sub-contractor, and having completed 45 F.Mk 4s, began building large numbers of whole aircraft with the F.Mk 8, such was the urgency of getting large numbers into service quickly. The company received Contract No.6/ACFT/2983 C.B.7(bl) and built WA755-WA994, WA808-812, WA965-WA969, WA981-WA999, and WB105-WB112. The second Armstrong Whitworth

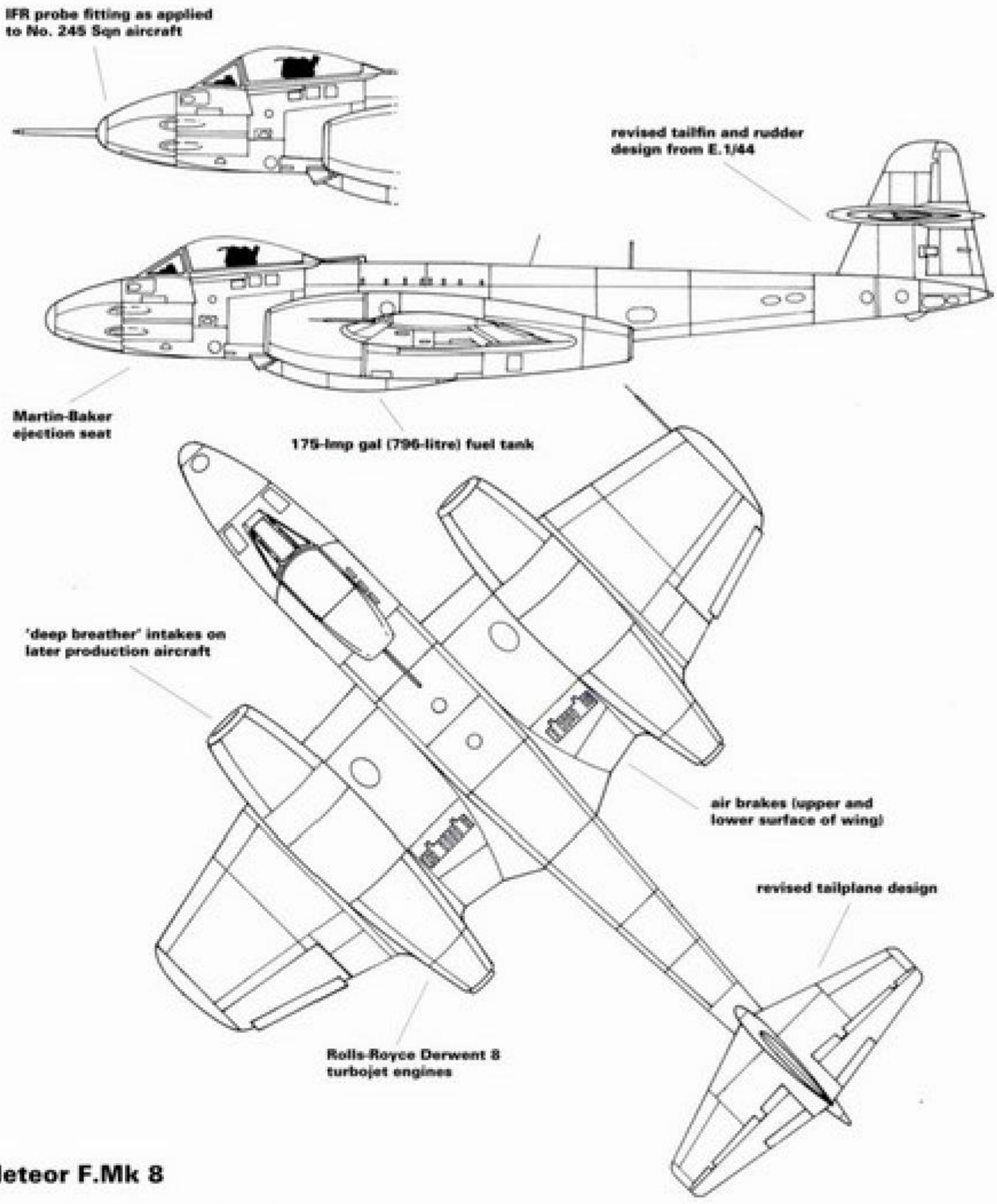
WA962 was among a sub-batch of Meteor Mk 8s constructed by Gloster, though originally included in an Armstrong Whitworth contract. It featured revised tailplane design, cartridge ejector chutes and the 175-Imp gal (796-litre) ventral tank.

contract was Contract No.6/ACFT/4040 C.B.7(bl), covering WE852-WE891, and WE895-WE902, with WF639-WF662 and WF677-688 following under Contract No.6/ACFT/5043 C.B.7(bl). The next Armstrong Whitworth batches were built to meet Contract No.6/ACFT/5621 C.B.7(bl, with WH249-WH263, WH272-WH320, WH342-WH386, WH395-WH426, WH442-WH444, WH445-WH484, and WH496-WH513. Armstrong Whitworth also built some sub-batches of aircraft ordered under a Gloster Contract (No.6 /ACFT/6066 C.B.7(bl): WK707-756 and WK906-WK934.

The Meteor F.Mk 8 saw front-line service with Nos 1, 19, 34, 41, 43, 54, 56, 63, 64, 65, 66, 72, 74, 92, 111, 222, 245, 247, 257 and 263 Squadrons, RAF, and with Nos 500, 501, 504, 600, 601, 604, 609, 610, 611, 615 and 616 Squadrons, Royal Auxiliary Air Force. The Meteor F.Mk 8 began to give way to the Hunter in 1954, though Nos 64 and 72 converted to Meteor night-fighters, No. 92 to the Sabre, and No. 56 to the Swift. The auxiliary units disbanded altogether in 1957. The last front-line fighter unit was No. 245 Squadron, which re-equipped with Hunters in April 1957. Other F.Mk 8s served with a host of Flying Training Schools, Station Flights, and with No. 85 Squadron, No. 5 CAACU, and No. 1574 Flight in the target facilities role. A number of Meteor night-fighter, Hunter and other squadrons also used F.Mk 8s as trainers or as 'hacks', including Nos 1, 25, 29, 33, 111, 151 and 153 Squadrons.

During production, a number of improvements were made to the Meteor F.Mk 8, some of which were immediately obvious externally. All but the prototype and a small number of the VZ-serialled production batch of F.Mk 8s were fitted with prominent cartridge ejector chutes because the lengthened nose had effectively positioned the original ejector slots further forward, and spent cartridges now tended to hit or score the ventral tank, when carried. The first aircraft to test the new chutes was VZ657. A subtle change was the provision of new wider-diameter intakes that allowed greater mass flow and were colloquially known as 'deep breathers'. The new intakes provided 240 lb st (1.07 kN) more thrust per engine, and were fitted to most WK and WL serialled F.Mk 8s on the production line. Other late features included a whip VHF aerial and a clear-view blown canopy, without the metal rear fairing featured on early F.Mk 8s. These features were sometimes also incorporated by retrofit (the new intakes appearing for example on WE876, WF654, WH286l, and by the time the F.Mk 8 left front-line service, most had the clear-view canopy, though many aircraft still had the earlier, narrow air intakes.

A number of Meteor F.Mk 8s were modified by Flight Refuelling Ltd for inflight-refuelling trials with USAF KB-29 tankers. These aircraft had a probe added to the tip of the nose, and 16 were issued to No. 245 Squadron at Horsham St Faith in 1951-52. The squadron slotted inflight refuelling into its normal training programme, and on occasion kept up to six aircraft airborne for periods of up to four hours. The modified aircraft included WA823, WA826, WA827, WA829, WA830, WA832, WA834, WA836 and WA837. One of these aircraft (WA830) was also fitted with underwing tanks, as

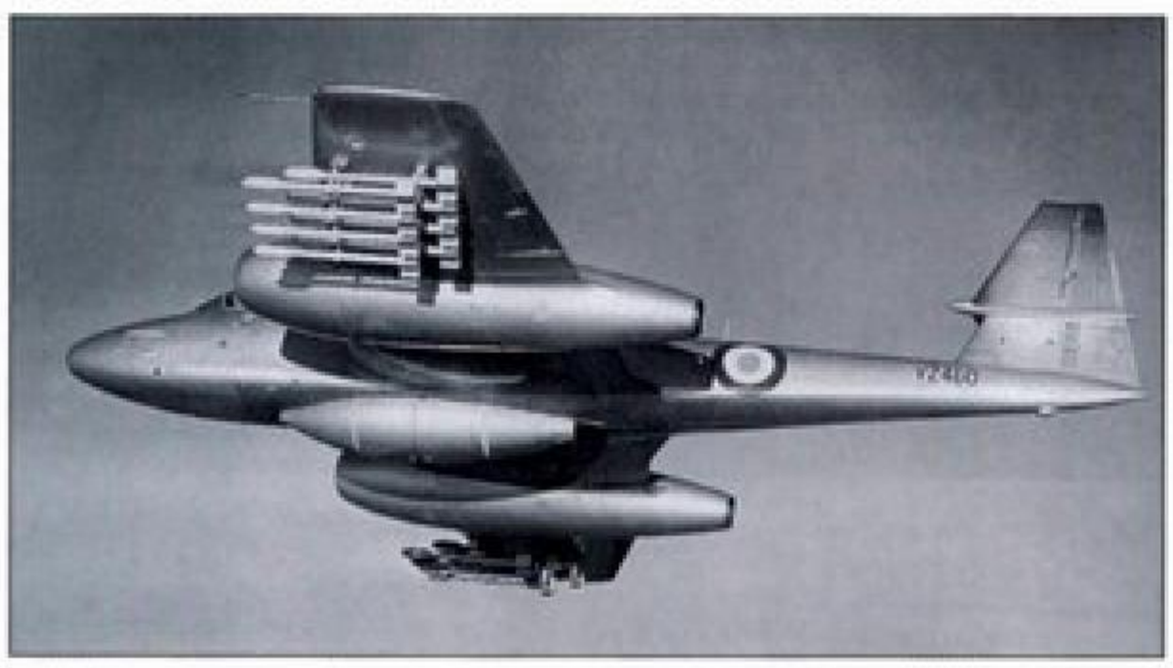

IFR probe fitting as applied to No. 245 Sqn aircraft
revised tailfin and rudder design from E.1/44
Martin-Baker ejection seat
175-Imp gal (796-litre) fuel tank
'deep breather' intakes on later production aircraft
air brakes (upper and lower surface of wing)
revised tailplane design
Rolls-Royce Derwent 8 turbojet engines

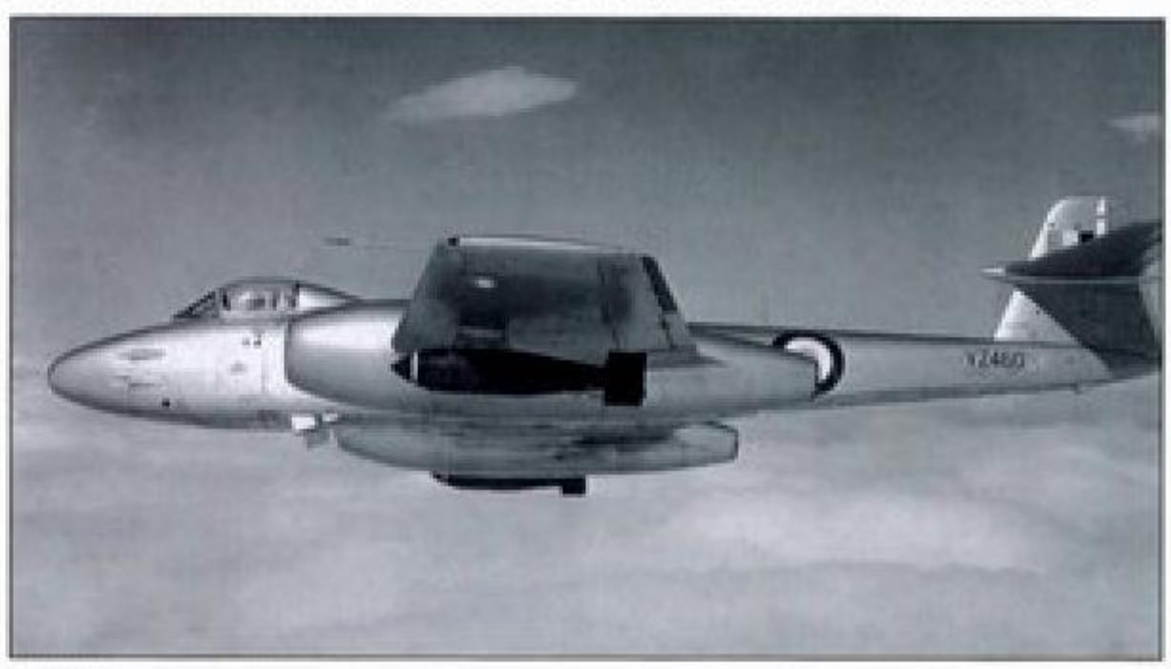
Meteor F.Mk 8

developed for and tested on the Reaper.

Meteors used by the RAAF in Korea were the first modified for the ground attack role, with provision for underwing rockets or bombs (never standard on RAF Meteors). One in four was immediately fitted with radio compasses, allowing them to operate more easily alongside USAF fighters.

An early Mk 8, VZ460 was engaged in acceptance trials for bomb and rocket projectile carrier installations. Up to 16 60-lb RPs (below left) or two 1,000-lb bombs (below) could be carried in place of two 100-Imp gal (455-litre) drop tanks, though neither weapon was to become a standard fit on RAF Mk 8s. After service at RAE Farnborough, '460 was scrapped in December 1957.





Gloster Meteor Variants

No. 245 Squadron, RAF operated the 16 Mk 8s with inflight-refuelling probes fitted by Flight Refuelling Ltd. Trials were successfully carried out with USAF KB-29 tankers, but a lack of funding prevented the extension of the modification to other units. Also evident on this aircraft are the smaller engine intakes fitted to early production aircraft and replaced on later examples with so-called 'deep breathers' of greater diameter. These permitted a higher mass flow and thus greater thrust.

The last F.Mk 8 (WL191) made its maiden flight at Hucclecote, in the hands of Jim Cooksey, on 9 April 1954. Despite its RAF serial, WL191 was destined to be delivered to Egypt, one of a small number of Meteors built to meet RAF contracts which were delivered to foreign customers, often without seeing RAF service. Other F.Mk 8s were built from the start for export, and never received RAF serials. These aircraft are described in the next entry.

Like Canada and New Zealand, Australia was allocated a Meteor F.Mk 3 for trials and evaluation, partly in the hope that the RAAF would order the type. Post-war austerity prevented any order for a jet fighter from being placed until late 1950, when the RAAF's No. 77 Squadron (part of the Allied occupation forces in Japan) found itself at war in Korea. This conclusively demonstrated the urgent need for jet fighters. Uncertainty over delivery schedules and a shortage of US dollars prevented the RAAF from ordering the F-86 Sabre, and the Meteor F.Mk 8 was selected for service instead. Some 36 were ordered, together with two T.Mk 7s.

The demands of war were heavy, and many Meteors were written off. An eventual total of 94 Meteor F.Mk 8s was allocated, but one (probably additional) F.Mk 8 (WA395, A77-300) was written off in March 1952 en route from the UK. Seven T.Mk 7s were also delivered. No. 77 Squadron converted to the Meteor F.Mk 8 from the Mustang in May 1951, moving to Kimpo and beginning combat operations in July. Meteors deployed to Korea were equipped with ARN-6 radio compasses. Withdrawn from offensive fighter sweeps, the aircraft was initially restricted to airfield defence and defensive duties after December 1951, following heavy losses. From January 1952, however, the Meteor's stability and twin-engined safety were exploited in the fighter-bomber role, hastily modified to carry USAF HVAR rockets or 500-lb bombs. The squadron flew 18,872 sorties during the war, and lost 32 pilots in Meteors, scoring three confirmed air-to-air kills. Surviving Meteors were flown briefly by Nos 75 and 77 Squadrons at Williamtown, and then by Nos 22 and 23 Squadrons of the Citizen's Air Force until June 1960. An aerobatic team was formed, known as the 'Meteorites'. A handful served on in the communications role. The Australian Meteors received random serial numbers between A77-4 and A77-982, and consisted of the aircraft listed below.

WA680, WA782, WA783, WA786, WA909, WA934, WA935, WA936, WA937, WA938, WA939, WA941, WA942, WA944, WA945, WA946, WA947, WA948, WA949, WA950, WA951, WA952, WA954, WA956, WA957, WA958, WA960, WA961, WA964, WA998, WE559, WE874, WE877, WE880, WE886, WE889, WE890, WE896, WE898, WE900, WE903, WE905, WE906, WE907, WE908, WE911, WE918, WE928, WE969, WE971, WF653, WF746, WF750, WH252, WH254, WH259, WH274, WH405, WH414, WH417, WH418, WH475, WH479, WK650, WK670, WK674, WK682, WK683, WK684, WK685, WK686, WK688, WK715, WK727, WK728, WK730, WK735, WK748, WK791, WK792, WK796, WK798, WK800, WK821,WK907, WK909, WK910, WK912, WK913, WK931, WK937, WK938,WK944, WK973,

These were respectively reserialled A77-705, A77-730, A77-446, A77-744, A77-959, A77-354, A77-300, A77-373, A77-811, A77-29, A77-587, A77-163, A77-735, A77-231, A77-316, A77-911, A77-741, A77-740, A77-139, A77-982, A77-728, A77-368, A77-721, A77-616, A77-726, A77-464, A77-949, A77-189, A77-17, A77-802, A77-559, A77-953, A77-393, A77-120, A77-645, reserialled A77-645, A77-157, A77-570, A77-397, A77-134, A77-415, A77-31, A77-510 or A77-207, A77-251, A77-734, A77-128, A77-15, A77-385, A77-627, A77-193, A77-436, A77-920, A77-46, A77-422, A77-793, A77-258, A77-11, A77-343, A77-865, A77-866, A77-862, A77-861, A77-65, A77-852, A77-854, A77-860, A77-868, A77-858, A77-851, A77-857, A77-867, A77-856, A77-859, A77-853, A77-869, A77-855, A77-863, A77-864, A77-870, A77-871, A77-872, A77-873, A77-875, A77-876, A77-879, A77-878, A77-874, A77-880, A77-883, A77-877, A77-884, A77-882, A77-886, A77-881, and A77-885.

Eight ex-RAF Meteor F.Mk 8s were eventually delivered to Egypt (in 1955) to replace embargoed aircraft diverted to Brazil and Israel in 1953. Serialled 1415, 1419, 1420, 1421, 1423, 1424, 1425 and 1426, the aircraft had previously been WL138, WL186, WL187, WL188, WL189, WL191 and WH371, respectively.

Syria eventually received seven ex-RAF F.Mk 8s, following an embargo and the delivery of 12 replacement aircraft between December 1952 and March 1953. The last Syrian F.Mk 8s were 413-419, previously WA785, WL174, WK868, WK984, WH503, WE965, and WH260.

This formation of No. 41 Sqn Meteor F.Mk 8s includes an aircraft with 'deep breather' intakes, second from the camera.

Export Meteor F.Mk 8

The Meteor F.Mk 8 proved popular with a number of operators of the earlier F.Mk 4. The F.Mk 4 had sometimes sold because it was available, and rivals were not, but in service the aircraft proved agile, durable and versatile. Moreover, though Australian Meteor F.Mk 8s had proved wanting against Russian-flown MiG-15s in high-altitude dogfights, the aircraft had not received the 'drubbing' which was sometimes suggested. In the ground attack and low-level air defence roles, the Meteor F.Mk 8 had proved to be generally impressive, and the aircraft packed a heavier punch than any other Western jet fighter. The only better alternative was the Sabre, and many believed that the US aircraft was harder to maintain and operate, and might even prove inferior at low level and in European weather conditions. In any case, with the Korean War still raging there was some concern that Sabre deliveries would be intermittent, at best.

After evaluating a number of competing aircraft types, the Netherlands decided that the best replacement for its Meteor F.Mk 4s would be the Meteor F.Mk 8, and negotiated for Fokker to produce the type under licence. An initial five ex-RAF aircraft were followed by 155 aircraft built by Fokker and delivered between 12 January 1951 and 15 February 1954. The aircraft served with Nos 323, 324, 325 and 326 Squadrons at Leeuwarden, and with Nos 322, 327 and 328 Squadrons at Soesterberg. No. 324 Squadron was the first to convert to the F.Mk 8, in January 1951, and the reserve No. 322 was the last, in 1953. The Meteor F.Mk 8s were replaced in the front line by Hunters between December 1955 and 1958. A handful of F.Mk 8s remained in use as target tugs until May 1959.

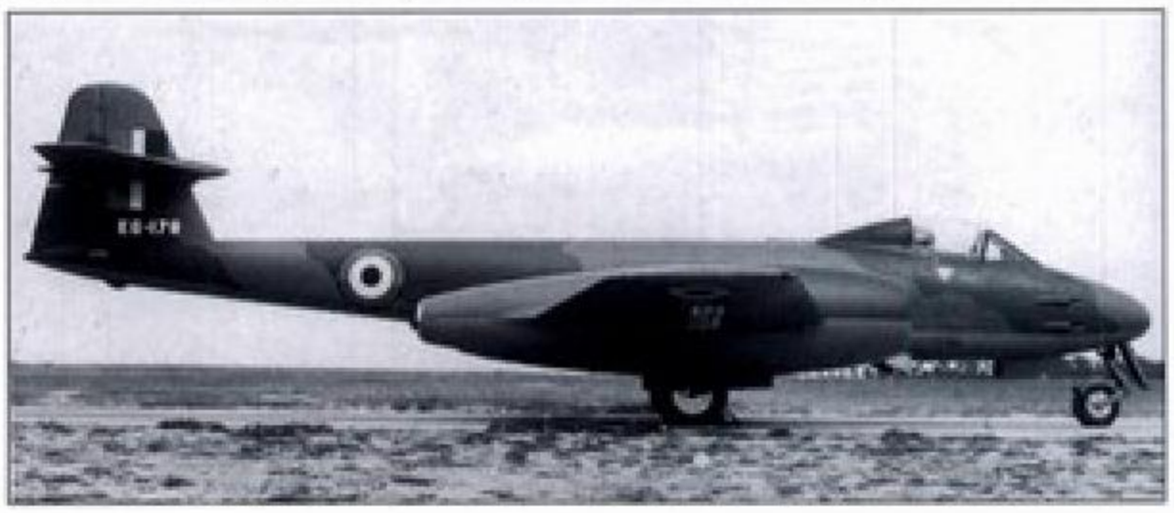
Neighbouring Belgium also replaced its Meteor F.Mk 4s with new F.Mk 8s, ordering an initial 23 refurbished ex-RAF aircraft in 1949, and 150 more Fokker-built aircraft in 1950. Some 67 additional F.Mk 8s were built by Avions Fairey, using 30 Fokker-supplied kits and 37 kits supplied by Gloster. The F.Mk 8s replaced F.Mk 4s with Nos 349 and 350 Squadrons at Beauvechain, with No. 1 Wing. The wing's Nos 4, 10 and 11 Squadrons also received F.Mk 8s, as did No. 7 Wing at Chièvres (Nos 7, 8 and 9 Squadrons), No. 9 Wing at Bierset (Nos 22 and 26 Squadrons) and No. 13 Wing at Brustem (Nos 25, 29 and 33 Squadrons). Replaced in the front line by Hawker Hunters from 1956, Meteor Mk 8s served as target tugs until at least 1962.

The first overseas order for the F.Mk 8 was placed by Egypt, but a British government embargo prevented delivery of the 24 aircraft on order. All had their tropical equipment removed, before14 were diverted to RAF contracts, while the other 10 formed half of the 20-aircraft order placed by Denmark in April 1950. The 20 Danish aircraft, serialled from 481 to 500, were delivered between January and June 1951, equipping No. 724 Squadron. Replaced in the front-line fighter role by Hunters in 1956, some Meteors remained in use as target tugs until 1962.

When Britain ended its embargo on arms deliveries to the Middle East, approval was eventually given for the delivery of 12

Aircraft 490 was the 10th of the 20 Mk 8s ordered by the Royal Danish Air Force to RAF F.Mk 8 standard and delivered in the first half of 1951. Grey/green camouflage was standard on RDAF Meteors, including Mk 4s, T.Mk 7s and NF.Mk 11s.

Belgium's Mk 8s were a mixture of ex-RAF examples refurbished by Avions Fairey, new machines built in the Netherlands by Fokker and a number assembled by Avions Fairey using kits supplied by Fokker and Gloster. EG-179 was one of 30 Fairey aircraft built with Dutch components.



Meteor F.Mk 8s. The first four were serialled 1416, 1417, 1418 and 1422 and were delivered to Egypt in February 1953. The Suez Canal crisis then prompted a new embargo, and the original 1415, 1419, 1420, 1421 and 1423 were diverted to Brazil, and 1424, 1425 and 1426 to Israel. These aircraft were eventually replaced by others using the same Egyptian serials, and detailed in the entry above.

All of the Middle Eastern customers for the Meteor were effected by embargoes. Syria's original 1950 order for 12 F.Mk 8s (to be diverted from RAF contracts) was embargoed in October 1951 and the aircraft allocated were instead delivered to the RAF. When the embargo was lifted in September 1952, 19 new Meteors were re-ordered, the first 12 of which were new-builds, not diverted from RAF contract.

Remarkably, Israel's Meteors were not delayed by embargoes, and, in a supreme irony, the country even benefited from embargoes against its enemies, taking three aircraft once destined for Egypt. Israel ordered 11 Meteor F.Mk 8s on 10 February 1953, at £36,250 each, along with four £34,250 T.Mk 7s. The F.Mk 8s were the most advanced produced up to that time, with Martin-Baker M2E ejection seats, target-towing lugs, and provision for underwing rocket projectiles, and were fitted with Hispano cannon provided by Israel. The Meteors were fitted with civilian Derwent 8s, which would reduce the impact of any future embargoes. They were delivered between 21 August 1953 and 17 January 1954.

The Israeli F.Mk 8s and T.Mk 7s were used to form No. 117 'First Jet Fighter' Squadron, which acted as the country's first operational jet fighter unit, but which was also tasked with advanced pilot training, converting as many pilots as possible to jet fighters. The aircraft flew CAS and reconnaissance missions in the 1956 Suez campaign, but quite soon afterwards relinquished their front-line role, and No. 117 squadron became a dedicated advanced training and fighter lead-in unit until it disbanded on 11 February 1962. The F.Mk 8s and FR.Mk 9s then served with the 'Knights of the Orange Tails' Squadron in the target facilities role. They were retired in 1964.

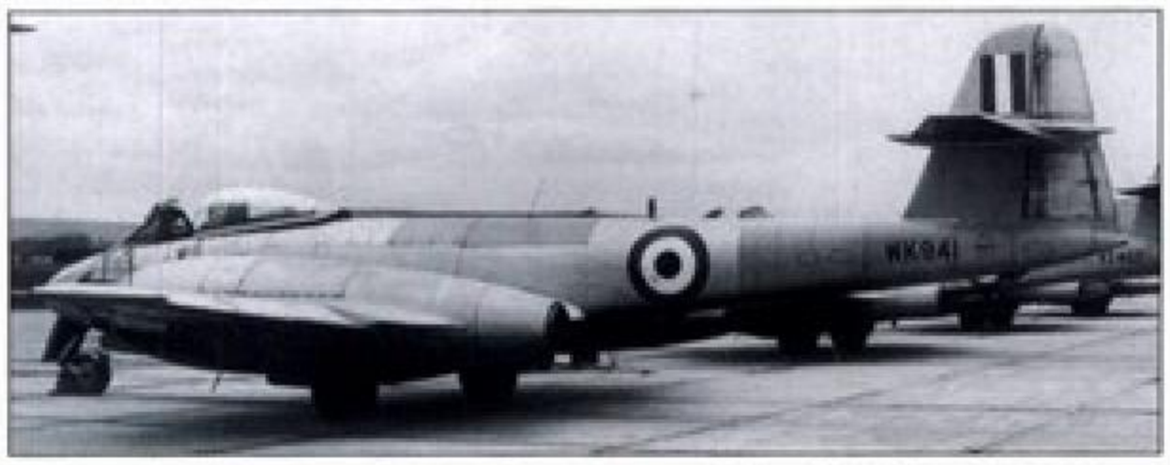
US unwillingness to allow the export of early jets to Latin America gave the Meteor (and other British first-generation jets) a useful advantage in winning export orders, which was vigorously exploited by de Havilland with the Vampire and Venom, English Electric with the Canberra, and Gloster with the Meteor. The only Latin American nation to take delivery of F.Mk 8s was Brazil, placing Gloster's biggest export order for new-build F.Mk 8s. Although Brazil's order for 70 Meteors (including 10 T.Mk 7s) consisted mainly of new-build aircraft, a handful are quoted as having had RAF serial numbers. Some reports have suggested that 4455-4458 were ex-RAF aircraft WK877, WK887, WK888 and WK889, but this is demonstrably false, since these aircraft all had long RAF careers and their fates are known. The Brazilian Meteors were paid for with 15,000 tons of raw cotton, and were delivered by sea in 1953-54. They were broadly equivalent to RAF F.Mk 8s, but were fitted with a radio compass. They replaced ageing P-47 Thunderbolts, which had been rendered obsolete overnight by neighbouring Argentina's procurement of Mk 4 Meteors. The F.Mk 8s were serialled 4400-4459 in Brazilian service. Another aircraft (4600, an F.(TT) Mk 8) was built from spares by the FAB at São Paolo and was believed to be the last of the type left in service when it was finally retired in April 1974, although the replacement Northrop F-5Es did not start arriving with 1º GAVCa until June 1975. Brazil's Meteors may have lasted some months longer than has generally been supposed, although their place in the front line had effectively been taken by Mirage IIIs from 1972-73. An estimated 40 Meteors of all marks remained in use in 1970, and between 10 and 14 eventually found their way into museums.

Complete with rails for RPs, 2176 was among the 11 Mk 8s ordered by the Heyl Ha'Avir in early 1953. Ironically, the last three aircraft in this batch, including 2176, were originally intended for Egypt. During fighting in 1956, Israeli Meteor Mk 8s engaged Egyptian Vampires, downing at least three.

Meteor 'F(TT).Mk 8'

A number of Meteor Mk 8s were fitted with a simple target-towing lug on the centreline, immediately behind the underfuselage fuel tank. This allowed them to tow a simple target banner or drogue. Unofficially designated 'F(TT).Mk 8', the target-towing Meteors flew with a number of front-line Hunter, Meteor night-fighter and Javelin squadrons, with dedicated target-towing units, and with target-towing flights attached to training units. The aircraft sometimes received black and yellow target-towing striped undersides, but this was by no means universal.

Examples of the 'F(TT).Mk 8' included VZ438, VZ467, VZ494, VZ521, VZ549, VZ567, WA763, WA830, WA926, WA943, WA963, WE876, WF643, WF654, WF711, WH286, WH291, WH398, WK655, WK740, WK814, WK817, WK884, WK918, WK921, WK941, WK988, WL109, WL121 and WL180, although this list is far from exhaustive.



The target-towing lug under the fuselage centreline of this No. 229 OCU aircraft may be seen in the view above. This unit became No. 1 Tactical Weapons Unit in 1974, moving from RAF Chivenor to Brawdy. 'F(TT).Mk 8' VZ467 (below), the last Meteor Mk 8 in RAF service, was operated by No. 1 TWU until 1982, finished in the markings of No. 615 Sqn.

Meteor 'T.Mk 8'

Large numbers of Meteor F.Mk 8s were converted to serve as advanced trainers, and were unofficially known as T.Mk 8s. One of the first conversions was WH301, others including WK663, WK914, WL181 and WL190. The aircraft were used for solo flying at the Meteor-equipped Flying Training Schools, and for refresher flying by senior officers returning to flying after a desk job.

Large patches of Dayglo paint made the 'T.Mk 8' advanced trainers highly visible to other air traffic.

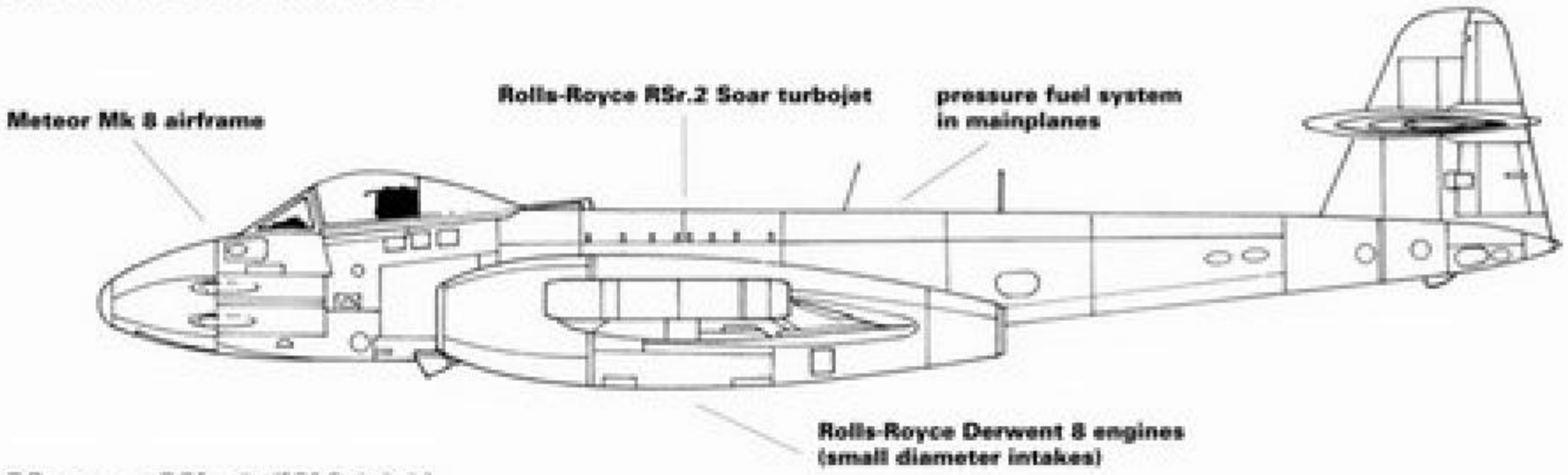
Meteor Mk 8 engine testbeds

The late 1940s and early 1950s were a time of great aeronautical progress, and jet and rocket engine development was exceptionally rapid, especially in the United Kingdom. A plethora of engine manufacturers had an almost insatiable appetite for aircraft which could be used as engine testbeds, allowing prototype or development engines to be tried in the air. The Canberra was probably the most popular engine testbed, but a number of Meteor F.Mk 8s were also used. VZ517, for example, had an Armstrong Siddeley Screamer rocket engine and its LOX tank fitted in a modified ventral tank, and carried wide-cut gasoline in the former ammunition bay. A steel heat shield protected the underside of the rear fuselage. The Screamer was a controllable rocket generating 1,000-8,000 lb st (4.45-35.59 kN) thrust at sea level, and up to 9,500 lb st (42.25 kN) at 40,000 ft (12192 m). Trials showed the engine to be highly efficient, but it never reached production, being passed over when the RAF abandoned Liquid Oxygen as a rocket fuel, in favour of High-Test Peroxide.

Another F.Mk 8, WA982, was used to test the lightweight, expendable Soar turbojet, designed by Rolls-Royce for missile and drone applications. The Meteor had a Soar fitted to each wingtip, connected to the ventral tank, which carried their special fuel. WA982 first flew with the Soars fitted on 25 February 1954, and continued development until 1956, when the aircraft was delivered to Flight Refuelling for drone conversion.

Perhaps the most powerful Meteor to fly was WA820, fitted with a pair of early Sapphire turbojets, rated at 7,600 lb st (33.80 kN) each. This aircraft was flown by Flight Lieutenant Rob Prickett to set an FAI time-to-height record on 31 August 1951.

WA982 only flew briefly, during the 1954 Farnborough air show, with two Rolls-Royce Soar engines installed. The aircraft was otherwise flown with one of the tiny turbojets on the port wingtip only, a ballasted engine casing being carried on the opposite side. When testing was completed in 1956, the aircraft reverted to F.Mk 8 standard before ultimately joining the U.Mk 16 drone programme.

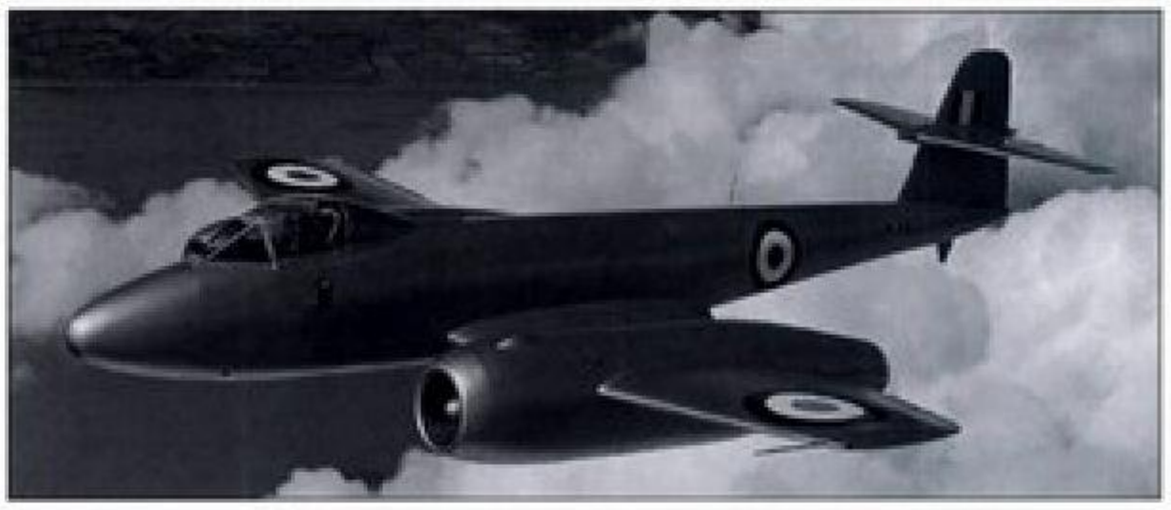

Meteor Mk 8 airframe
Rolls-Royce RSr.2 Soar turbojet
pressure fuel system in mainplanes
Rolls-Royce Derwent 8 engines (small diameter intakes)

Meteor Mk 8 (WA982)

Right: During the 1954 SBAC air show at Farnborough, both of WA982's Soars were run once the Meteor was airborne. It is not known whether, as has been suggested by some sources, the aircraft ever flew any distance with its Derwents shut down, i.e. purely under Soar power.

Above: The Armstrong Siddeley Screamer rocket installation was carried in a nacelle under VZ517, which also held its LOX fuel.

Below: WA820, with its Armstrong Siddeley Sa.2 Sapphire axial-flow turbojets rated at over 7,600 lb (33.8 kN) thrust, was probably the most powerful of all Meteors. Note the enlarged tail bumper fitted to the aircraft.

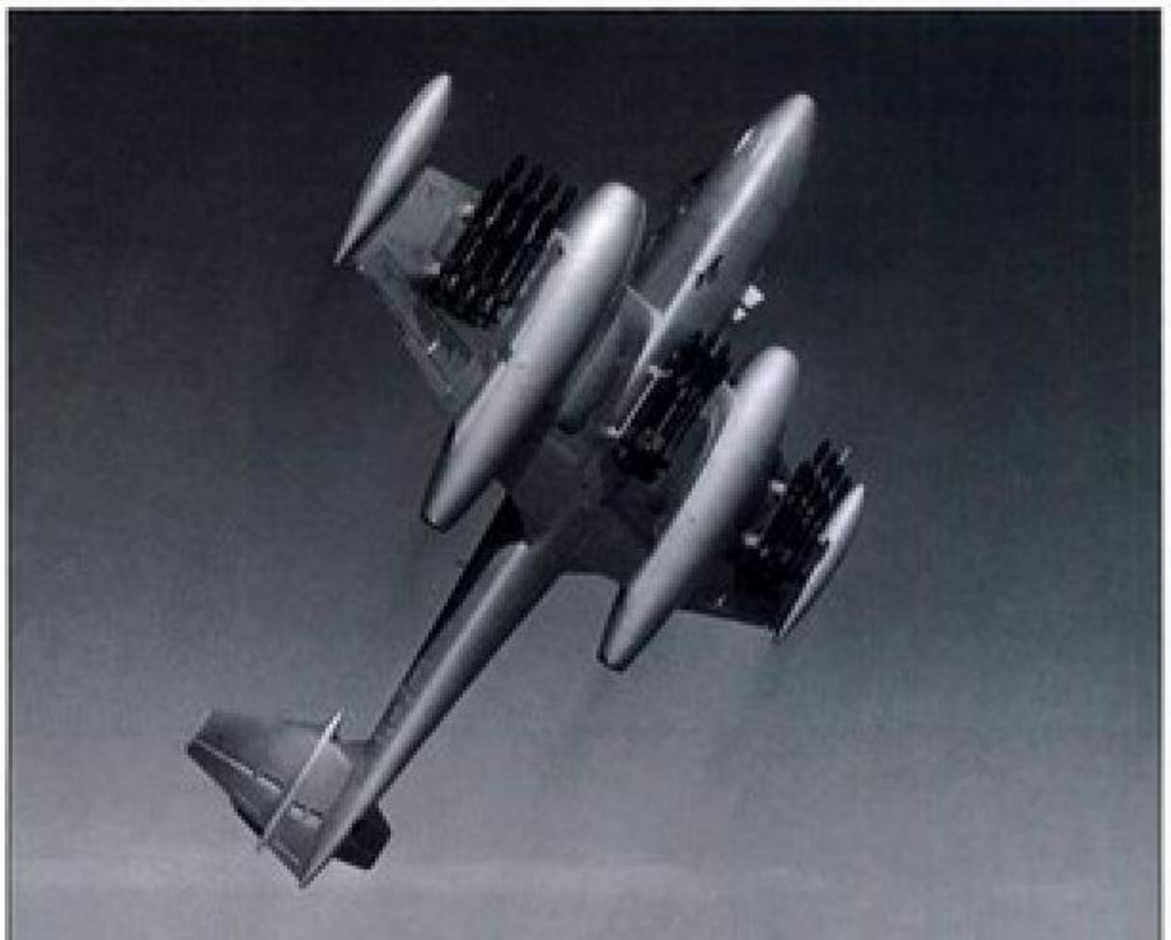


GAF Reaper (G.44)

The improved performance offered by the F.Mk 8 led to a number of studies aimed at increasing the Meteor's versatility, and thus its appeal. The most obvious new application for the Meteor was in the fighter/ground attack role for which greater firepower was thought to be useful. The first attempt to design a dedicated Meteor fighter-bomber resulted in the so-called 'Eight-Gun Meteor', which coupled the basic airframe of the F.Mk 8 with new outer wing panels. They were of slightly increased span, but were square-cropped, and each incorporated two 20-mm Hispano Mk 5 cannons, like those of the Meteor NF.Mk 11. Using these wings imposed an unacceptably low maximum speed, however, since the gun bay access panels reduced the wing's torsional stiffness and led to aileron reversal at speeds above 550 mph (885 km/h). This 'speed limit' was fine for the two-seat night-fighter versions, but was unacceptable in the single-seat fighter-bomber variant. The cannon-armed outer wings were redesigned, and eventually promised to allow a maximum speed of 600 mph (965 km/h), while containing 160 rounds of ammunition per gun.

By the time detail design work ended on the Ground Attack Fighter (GAF), the need for more than four cannon in the fuselage had been overtaken by the need to carry a greater weight of underwing bombs and rockets. The Ground Attack Fighter thus

Armed to the teeth with 24 rocket projectiles, the Reaper prototype is seen here in a classic Russell Adams/Gloster photograph. Four 1,000-lb bombs were an alternative load for this ground-attack variant, which could also carry a pair of 20-mm Hispano or 30-mm ADEN cannon in a centreline pod.



retained gunless outer wings, though they were redesigned and restressed to allow the carriage of a 1,000-lb bomb or eight 60-lb rockets underwing, on each side. The gunless wing was stiffened and fitted with spring tab ailerons, improving high-speed handling. Provision was also made for the fitting of 100-Imp gal (454-litre) tip tanks, which increased total fuel capacity to 995 Imp gal (4523 litre). When extra cannon armament was needed, the Ground Attack Fighter could carry two 20-mm Hispano or 30-mm ADEN cannon (each with 100 rounds per gun) in a modified underfuselage fuel tank.

Gloster financed the construction of a single prototype/demonstrator of what it called the 'Reaper'. Registered G-AMCJ (and later G-7-1), the aircraft lacked the airfield arrester hook and rocket-assisted take-off gear planned for the definitive GAF. Painted in Gloster's carmine red house colours (but later repainted silver), the aircraft was shown at the 1950 Farnborough air show, and was used for flight trials carrying a variety of weapon loadouts. The Reaper prototype demonstrated a maximum sea level rate of climb of 6,800 ft (2072 m) per minute, and could reach 30,000 ft (9144 m) (from brakes release) in 6.6 minutes. The aircraft also demonstrated maximum level speeds of 600 mph (965 km/h) at sea level and 558 mph (898 km/h) at 30,000 ft.

In parallel with the Reaper, Gloster studied a Meteor Armed Trainer (known internally as the P.307), which combined a T.Mk 7 fuselage with cannon-armed NF.Mk 11-style wings, but with square-cut tips like the F.Mk 8, and with provision for Reaper-style wingtip tanks. The aircraft remained unbuilt, although the Reaper itself was rebuilt with a T.Mk 7 forward fuselage as G-ANSO and used as a demonstrator. The aircraft was subsequently fitted with standard T.Mk 7 outer wings and tail unit, and was exported to Sweden as SE-DCC.

Left: As well as the Mk 8's standard underwing and centreline fuel tanks, the Reaper was able to carry 100-Imp gal (455-litre) tip tanks, boosting overall external tankage to 575 Imp gal (2614 litres). Seen here in its later overall silver guise as G-7-1, the Reaper prototype started life as G-AMCJ, finished in all-over carmine red.

Below: G-7-1 was rebuilt in 1954, a T.Mk 7 forward fuselage being fitted and the aircraft being registered G-ANSO as a company demonstrator, finished in larkspur blue. Four years later it was brought up to full T.Mk 7 standard and sold to Svensk Flygtjanst of Sweden as SE-DCC, for use as a target tug.

Prone Meteor

In an effort to find a solution to the growing problem of pilot *g* tolerance, it was decided to investigate the practicalities of accommodating the pilot in the prone position. This would reduce the effective vertical distance between the pilot's head and his heart, known to be a major factor in how much *g* a pilot can withstand. The programme was given extra impetus by the decision to develop a Bristol-designed rocket-powered interceptor, for which a prone pilot cockpit promised to allow a narrower fuselage cross-section.

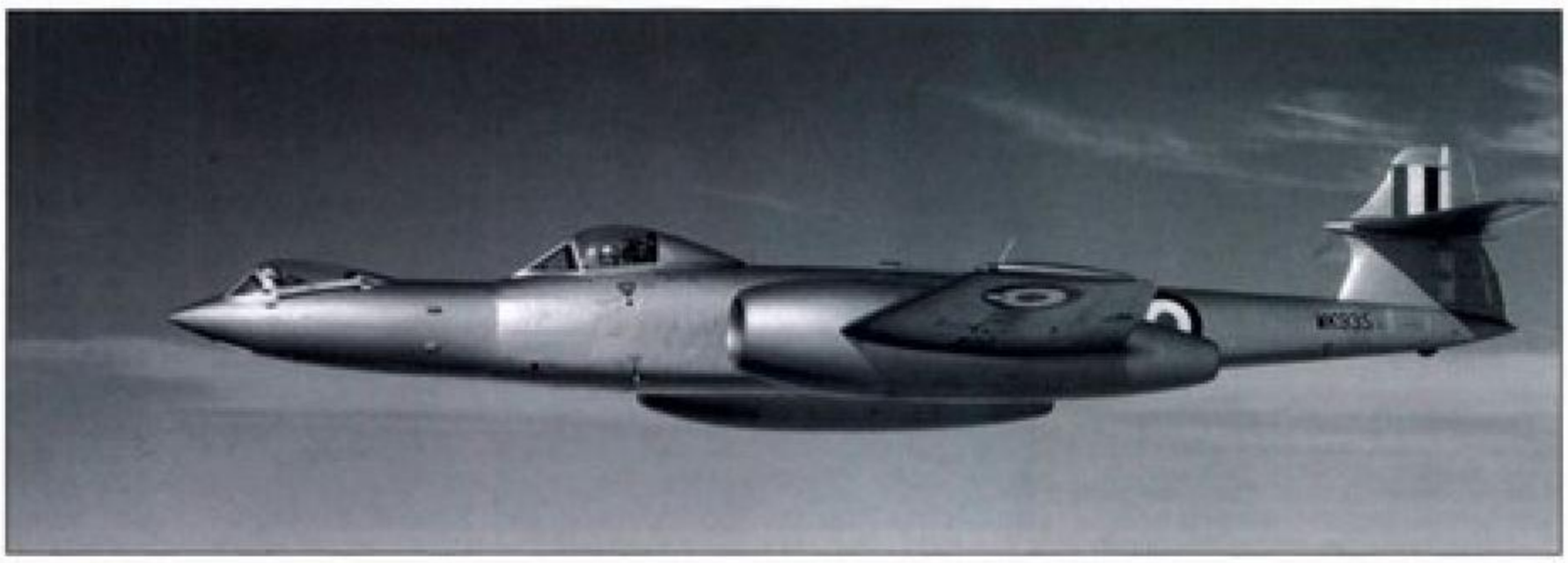
Armstrong Whitworth received a 1952 Ministry of Supply contract to convert an F.Mk 8 (WK935) to serve as a prone pilot testbed, with a new front cockpit in front of the normal cockpit. The prone pilot lay on a padded couch, with chin and arm rests, using hanging rudder pedals, a short control column and conventional engine controls. The aircraft was fitted with an increased-area NF.Mk 12-type tail unit, to compensate for the longer nose.

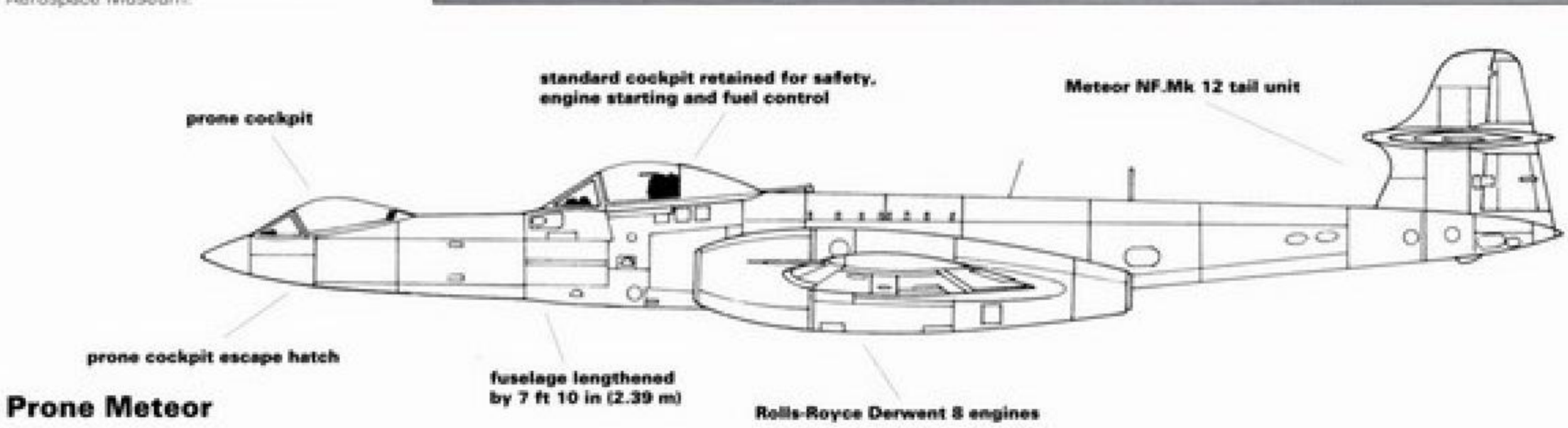
WK935 made its maiden flight in its new configuration on 10 February 1954, in the hands of Eric Franklin. Several pilots flew the aircraft from the forward, prone cockpit during an RAE/IAM test programme of 99 flights. A safety pilot always sat in the normal cockpit. In emergency, the front cockpit occupant would have had to retract the nosewheel, if extended, and then slide backwards off the couch and out through a jettisonable hatch in the underside. Fortunately, this never had to be proven.

The prone pilot position was found to improve *g* tolerance slightly, but the more difficult bailout characteristics were a concern; also, it was more difficult for the prone pilot to keep an adequate lookout, and the position proved tiring. The aircraft was eventually retired to the Cosford Aerospace Museum.

Right: Views of the Prone Meteor in this condition, prior to the application of an all-over silver finish, are comparatively rare. Just visible in the prone cockpit are ballast weights, presumably carried on the aircraft's first flights.

Below: In this air-to-air view, the Meteor NF.Mk 12 tail unit fitted to WK935 to compensate for its longer nose may be clearly seen.




standard cockpit retained for safety, engine starting and fuel control
Meteor NF.Mk 12 tail unit
prone cockpit
prone cockpit escape hatch
fuselage lengthened by 7 ft 10 in (2.39 m)
Rolls-Royce Derwent 8 engines

Prone Meteor

Meteor FR.Mk 9 (G.41L)

The Meteor FR.Mk 9 was a dedicated fighter-reconnaissance aircraft based on the airframe of the F.Mk 8, retaining that variant's armament. As such, it marked a replacement for the armed fighter reconnaissance Spitfires, like the FR.Mk XIV and FR.Mk XVIII, rather than for the unarmed high-flyers like the PR.Mk XIX. As such, the Meteor FR.Mk 9's reconnaissance camera fit was limited to a single nose-mounted F.24 camera, adjustable on the ground to look through one of three windows, in the port, starboard or forward oblique positions. The camera compartment was heated using bleed air from the starboard engine compressor.

A number of F.Mk 8s (and T.Mk 7s) were retrofitted with reconnaissance noses but were never used operationally and were never redesignated with the FR prefix. They included the A&AEE's VZ473.

The RAF ordered 126 Meteor FR.Mk 9s under Contract Nos 6 /ACFT/1389 C.B.7(b) (WW360-WW371), 6/ACFT/2430 C.B.7(b) (VZ577-VZ611), 6/ACFT/2983 C.B.7(b) (WB114-WB125 and WB133-WB143), 6/ACFT/5621 C.B.7(b) (WH533-WH557), 6/ACFT/6066 C.B.7(b) (WL255-WL265), and 6/ACFT/7252 C.B.7(b) (WX962-WX981). WW360, the first aircraft, made its maiden flight on 22 March 1950. The first delivery (of WW363) was made to No. 208 Squadron on 28 July 1950, and WX981 became the last to be delivered (to No. 79 Squadron), on 14 August 1952.

The Meteor FR.Mk 9 had a relatively short service career, giving way to Swift FR.Mk 5s and Hunter FR.Mk 10s. It served principally in RAF Germany and with the Middle East Air Force with Nos 2, 8, 79, 208 and 541 Squadrons, and with the Khormaksar (BFAP) Station Flight. The last FR.Mk 9s were retired in August 1960, from the British Forces Aden Protectorate Khormaksar Station Flight, though the fully-equipped squadrons had disappeared in 1956-58.

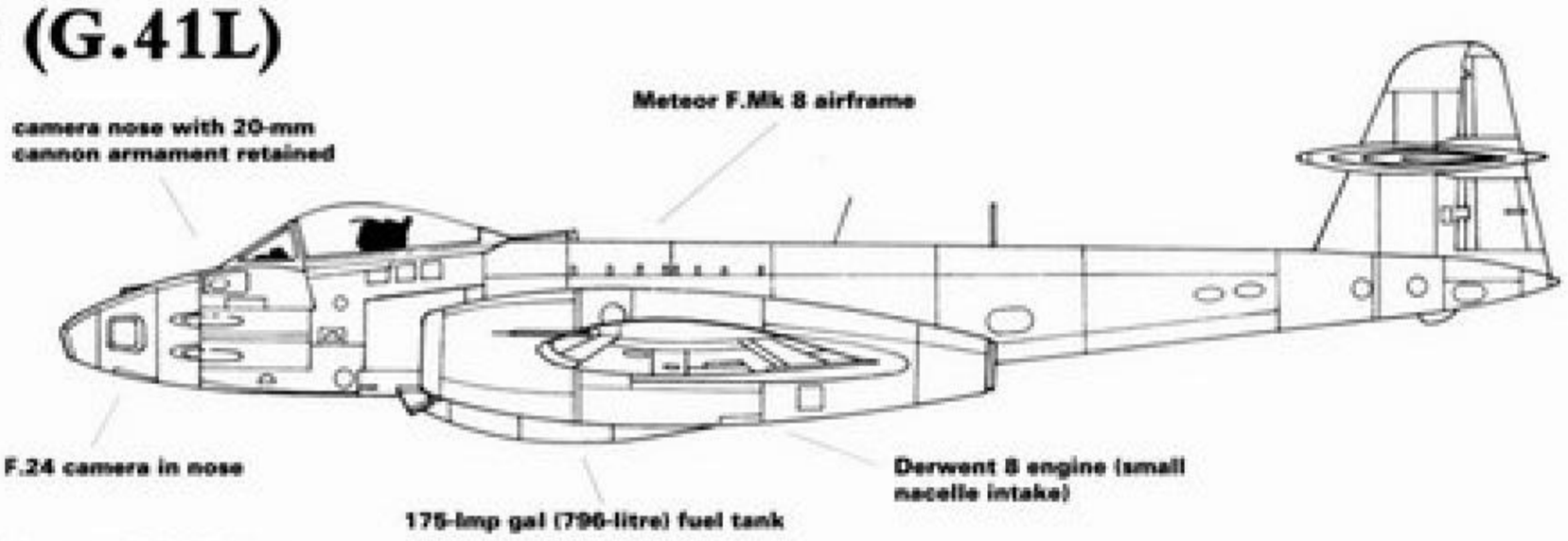
VZ608 was loaned to Rolls-Royce at Hucknall as an engine testbed, and was eventually used as a test platform for that company's RB.108 lift-jet engine, designed for the Short SC.1. The new lift-jet was mounted in the centre fuselage, in place of the centre-section fuel tanks, making the aircraft entirely reliant on the underwing tanks and limiting duration to 30 minutes. Miles Aircraft modified the aircraft with a replica of the SC.1's engine intake. Further V/STOL testbed Meteors were sketched by Gloster's design department, including the P.497, an F.Mk 8 with six vertically mounted RB.108s in modified nacelles, with the last engine on each side swivelling to provide some forward thrust. The T.Mk 7-based P.504 had 14 vertically mounted RB.108s in lengthened fairings based around the nacelle structure. Four more engines were scabbed onto the rear sides of the new fairing, providing fixed forward thrust. These two designs emerged in 1960, when Gloster was working on a number of STOL, VTOL and V/STOL transports and tactical strike aircraft projects.

Although no FR.Mk 9s were actually built for export, a number of ex-RAF Meteor FR.Mk 9s were refurbished for delivery to three overseas customers. Twelve were refurbished by Flight Refuelling Ltd for Ecuador and were delivered by sea during 1954-55. They were WW366, VZ597, VZ610, WB136, WH540, WH543, WH547, WH549, WH550, WH553, WH554 and WH555, originally serialled 703, 701, 705, 704, 706, 707, 702, 708, 709, 710, 711 and 712, respectively, and were reserialled with new serials including FF-112, 116, 119, and 123 (WH554). The Meteors served with Escuadrón de Combate 2111 at Taura until the last handful were finally replaced by Jaguar Internationals. Eight remained in use in 1969, and one was lost in service on 3 March 1975, surely the last front-line Meteor loss.

Seven more FR.Mk 9s were refurbished by Flight Refuelling for the Israeli Defence Force/Air Force and were delivered at much the same time as the Ecuadorian aircraft. The Israeli aircraft were WB123, WB140, WL259, WX963, WX967, WX975 and WX980. Most reports suggest that they were respectively serialled 213 (later 34), 214 (35), 212 (37), 216 (32), 211 (36), 215 (31) and 217 (33) in IDF/AF service, with most published photos showing Israeli Meteors carrying the later two-digit serials. Two, flying with No. 117 Squadron, claimed two of four Egyptian Vampires on 1 September 1955; Aharon Yoeli, in FR.Mk 9 '36', was the victorious pilot. By 1957, the Meteors had been relegated to the advanced training role (still with No. 117 Squadron, which became a fast jet OCU) and the type was phased out of service during the 1960s.

Two more FR.Mk 9s, WB133 and WX972, were delivered to Syria in 1956. Their subsequent Syrian identities were 480 and 481.

A handful of Australian F.Mk 8s are believed to have been briefly fitted with FR.Mk 9 noses, effectively turning them into FR.Mk 9s, though they were never designated as such.

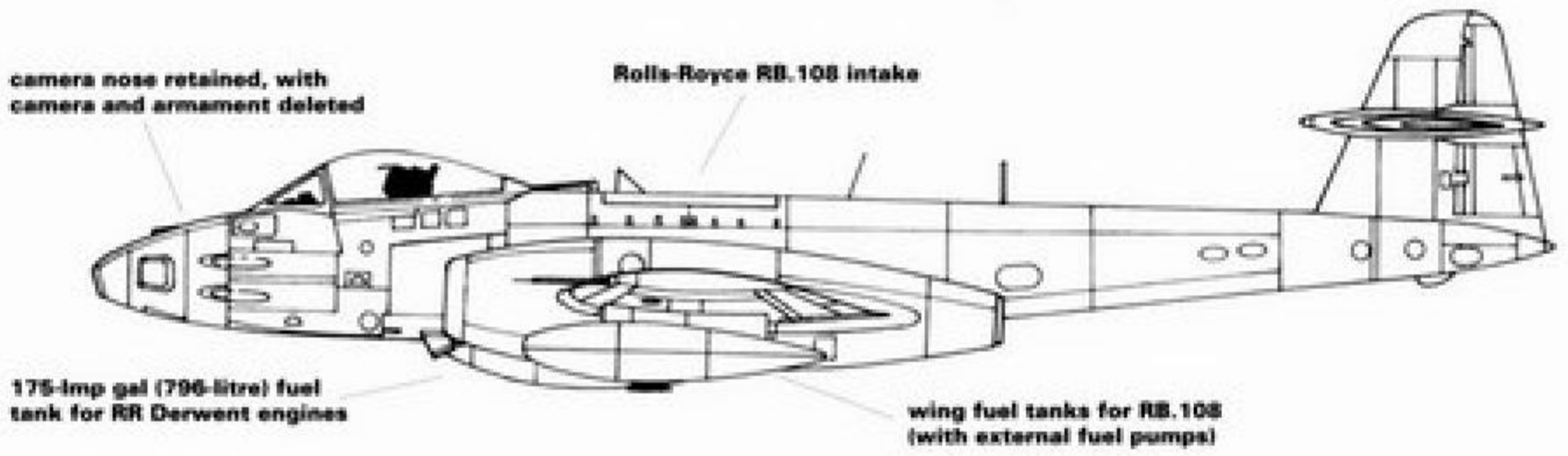

camera nose with 20-mm cannon armament retained
Meteor F.Mk 8 airframe
F.24 camera in nose
Derwent 8 engine (small nacelle intake)
175-Imp gal (796-litre) fuel tank

Meteor FR.Mk 9

Below: Handed over to Rolls-Royce in 1951, Meteor Mk 9 VZ608 was first test flown with small afterburners and later ground-tested a thrust reverser unit before being equipped, in 1955, with a fuselage-mounted RB.108 lift-jet. Here, the RB.108's intake, installed by Miles Aircraft, may be seen atop the fuselage. Fuel for the engine was held in the underwing tanks, each of which had an external pump, visible here.

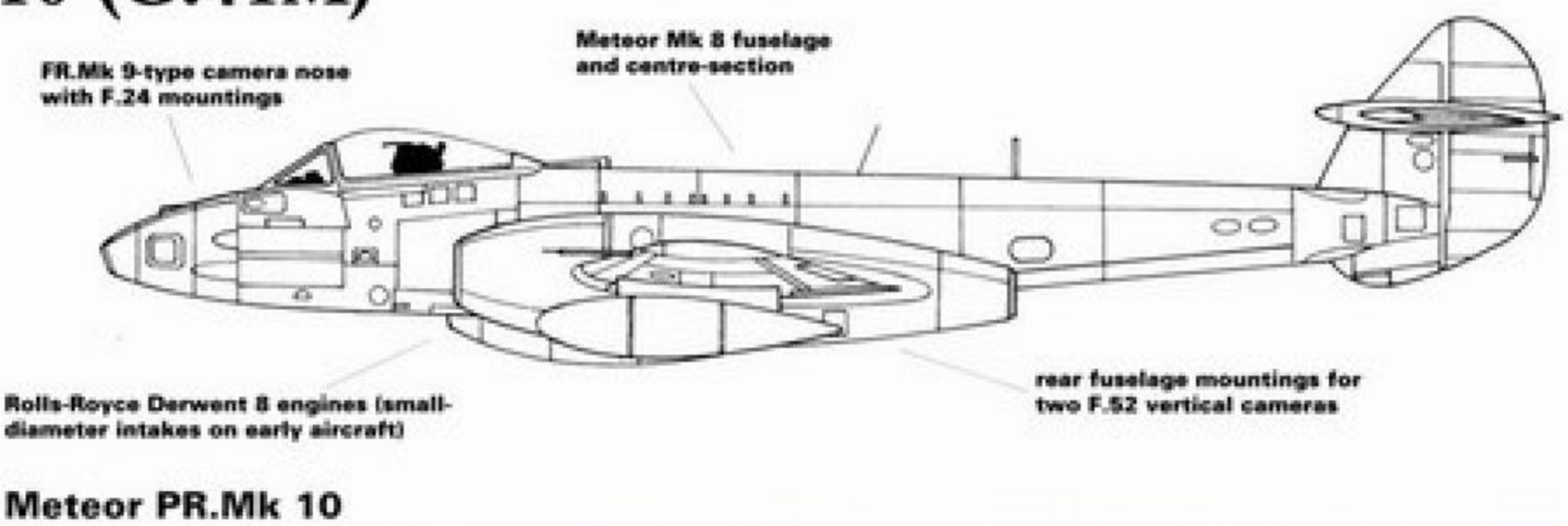
Left: This view of the third production Mk 9, VW362, clearly shows how the camera nose was simply grafted on to what was effectively a standard Mk 8 airframe. Initially employed in camera heating trials, VW362 later served at Farnborough and was sold in 1959.

Top: Re-equipping FR units then flying Spitfires, the Meteor Mk 9 served mainly with the 2nd TAF in Germany and in the Middle East. Like the PR.Mk 10, it was an interim type and enjoyed only a brief RAF career. In this view, the 'UU' codes of No. 226 OCU may be discerned above the port engine nacelle on VZ602.


camera nose retained, with camera and armament deleted
Rolls-Royce RB.108 intake
175-Imp gal (796-litre) fuel tank for RR Derwent engines
wing fuel tanks for RB.108 (with external fuel pumps)

Meteor Mk 9 (VZ608)

Meteor PR.Mk 10 (G.41M)


FR.Mk 9-type camera nose with F.24 mountings
Meteor Mk 8 fuselage and centre-section
Rolls-Royce Derwent 8 engines (small-diameter intakes on early aircraft)
rear fuselage mountings for two F.52 vertical cameras

Meteor PR.Mk 10

The Meteor PR.Mk 10 was a highly specialised aircraft, an unarmed high-altitude reconnaissance type designed to replace aircraft like the Spitfire PR.Mk 19 and Mosquito PR.Mk 34. Based on the stretched fuselage and centre-section of the F.Mk 8, the PR.Mk 10 reverted to the longer-span, round-tipped outer wing panels of the F.Mk 3 (as used on the night-fighter versions, but without armament). With no guns fitted, and thus with no ammunition bay, the aircraft was able to use the original rounded tailfin. Early PR.Mk 10s had the narrow-diameter original intakes, but most had the wider 'deep breathers', and most aircraft had, or were retrofitted with, the clear-view canopy. The aircraft used the same reconnaissance nose as the FR.Mk 9, but added an additional camera bay in the rear fuselage, behind the trailing edge, carrying two split vertical or combined vertical F.52 cameras. The new bay was heated using bleed air from the port engine compressor. All the camera windows could be fitted with protective metal covers which could be jettisoned after take-off.

With its long-span wings, powerful engines and lack of heavy armament, the PR.Mk 10 was the best-performing of any Meteor, in terms of climb and altitude performance. The aircraft could reach 44,000 ft (13411 m) with underwing tanks, or 47,000 ft (14325 m) clean. The type could climb to 30,000 ft in 6.2 minutes, and enjoyed a range of 1,085 miles (1746 km) and an endurance of 3 hours and 40 minutes. Its low wing loading (compared to the F.Mk 8) made it rather more agile, though maximum level speed was limited to only 501 mph (806 km/h) at sea level and 541 mph (870 km/h) at 40,000 ft.

PR.Mk 10 production totalled 59 aircraft, all built by Gloster, and produced to Contract Nos 6/ACFT/658 C.B.7(b) (VS968-VS987), 6/ACFT/1389 C.B.7(b) (VW376-VW379), 6/ACFT 2430 C.B.7(b) (VZ620), 6/ACFT/2963 C.B.7(b) (WB153-WB181), and 6/ACFT/6066 C.B.7(b) (WH569-WH573). Only the original F.Mk I and the highly specialised, tropical NF.Mk 13 were built in smaller numbers. VS698 acted as the prototype, and made its maiden flight on 29 March 1950, one week after the first FR.Mk 9, in the hands of Jan Zurakowski. The first delivery to a front-line unit was made on 2 February 1951, when VS698 was delivered to No. 541 Squadron. The last delivery (of WH573, to the same unit) was made on 3 April 1952. The PR.Mk 10s served with Nos 2, 13, 81 and 541 Squadrons.

As an unarmed reconnaissance platform, the Meteor PR.Mk 10 was little more than an interim aircraft, soon being effectively replaced by the faster, higher-flying, longer-ranged Canberra PR.Mk 3, which could also carry more cameras, of longer focal length. Some PR.Mk 10s served (especially in the Far East) until sufficient Canberra PR.Mk 3s and PR.Mk 7s had been produced, but increasingly took on a low-level role, sometimes operating with one engine flamed out to extend range. In Britain, Germany and the Middle East, the PR.Mk 10 had disappeared from service by the end of 1957, leaving only a handful in the Far East.

The PR.Mk 10s of No. 81 Squadron gained the distinction of being the last front-line single-seat Meteors in service. They served only with the RAF, none were built for export, and no ex-RAF aircraft were refurbished for overseas customers.

Three oblique camera ports – one in the extreme nose and one either side – were available for the F.24 camera, though the camera's position could only be adjusted on the ground. For its high-altitude role, the Mk 10 carried two F.52 cameras in the lower rear fuselage.

Above: The PR.Mk 10 combined the Mk 8's fuselage with the outer wings and tailfin of the Mk 3. The camera nose came from the FR.Mk 9.

Below: Though intended for high-altitude work, some RAF PR.Mk 10s were camouflaged, like this 2nd TAF-assigned No. 541 Sqn example, seen at Laarbruch in 1954. Underwing tanks were routinely carried by Mk 10s.

Meteor NF.Mk 11 (G.47)

The jet-powered night-fighter was born not long after the jet fighter itself. The Messerschmitt Me 262B-1a/U-1 was a radar-equipped two-seater designed to hunt Allied bombers and intruders by night, while the standard single-seater attacked day bombers. Any dedicated night-fighter had to have onboard radar, and this pre-supposed a second crew member to operate the equipment and interpret the displays.

As more powerful jet engines became available, jets became more capable of lifting heavier useful loads, and both jet bombers and jet night-fighters became an increasingly practical proposition. No-one seriously contemplated turning the Meteor into a bomber, but the performance advantages of the Derwent 8 engine, as used by the F.Mk 8, made it abundantly clear that a jet night-fighter variant would be a practical proposition.

Gloster had already been working on Meteor night-fighter studies when Specification F.44/46 (calling for a two-seat, twin-engined, all-weather fighter) was issued, and a night-fighter version of the Meteor was drawn up to meet Specification F.24/48, for an interim jet night-fighter, to be based on the two-seat Meteor trainer, modified to carry all necessary operational equipment. The Gloster design studies were handed to Armstrong Whitworth, another company within the Hawker Siddeley Group, whose extensive Meteor production experience and spare capacity ensured that it would produce any night-fighter variant of the aircraft. Armstrong Whitworth received Contract 6/ACFT/3433 C.B.5(b), covering the construction of three prototypes. Gloster, meanwhile, worked on what would become the Javelin to meet the original Specification.

The Meteor NF.Mk 11 was not the first radar-equipped Meteor, that distinction having gone to an F.Mk III (EE348) used for trials by the Central Radar Establishment in 1946. This aircraft was one of a number of radar-equipped F.Mk 3s and F.Mk 4s used by the CRE and the TRE (Telecommunications Research Establishment) which demonstrated the potential of the jet night-fighter, and the potential adaptability of the Meteor. The RAF was then still reliant on the de Havilland Mosquito in the night-fighter role, and this aircraft, with its 380 mph (612 km/h) performance, was rightly seen as being on the verge of obsolescence.

The fourth production T.Mk 7 was set aside to serve as the NF.Mk 11 prototype and received a lengthened nose, PR.Mk 10 outer wing panels modified to accommodate four 20-mm Hispano Mk V cannon, each with 160 rounds of ammunition and a Martin-Baker flat feed system. This was 140 rounds fewer than the 780 carried by the F.Mk 8 and some other variants. The wings were stiffened to compensate for the large cannon and ammunition access panels. It was decided that the cockpit would be pressurised to maintain a cabin altitude of 24,000 ft (7315 m) when flying at 40,000 ft (12192 m), and the T.Mk 7-type cockpit had to be thoroughly sealed. Finally, and belatedly, the decision was taken to fit the larger and more streamlined F.Mk 8-type tail unit.

VW413 first flew in its new configuration at Baginton in October 1949, without radar or operational equipment. The success of

VW413, the fourth production T.Mk 7 trainer, was rebuilt as the aerodynamic prototype for the NF.Mk 11 and flew as such in October 1949. As well as the modified nose, a Mk 8-type tail unit was fitted, though no radar or other operational equipment was installed.

Gloster Meteor Variants

The first of three Mk 11 prototypes, WA546 was completed by Armstrong Whitworth Aircraft in 1950 and test flown by AWA's chief test pilot, Sqn Ldr E. G. Franklin, on the last day of May. A second prototype (WA547) and a pre-production aircraft (WB543)followed.

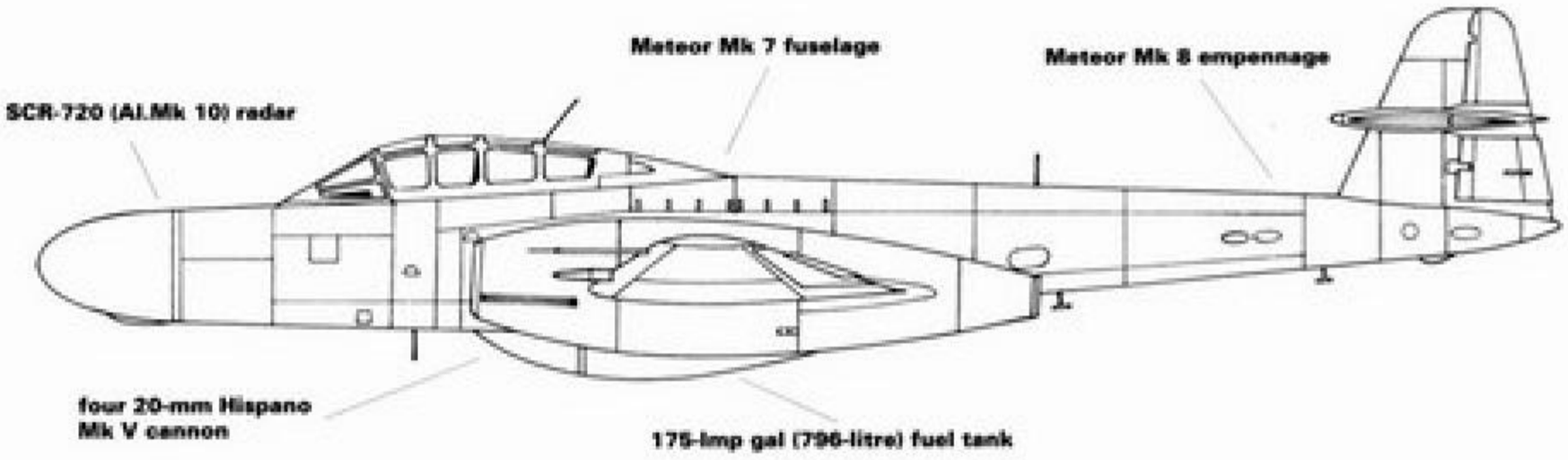
this aircraft led to a production order for 200 NF.Mk 11s, and three pre-production, production-standard prototypes, WA546, WA547 and WB543.

When it made its maiden flight on 31 May 1950, WA546, the first NF.Mk 11 prototype, represented a significantly less capable and less advanced aircraft than some of Gloster's existing Meteor all-weather fighter studies. The P.298, for example, drawn in September 1949, had a pair of reheated Derwent 5 engines, while the P.300 of October 1949 was similarly powered, but also incorporated modest sweep on the outer wing panels, with no taper on the trailing edge. The company had previously sketched a swept-wing, Avon-engined night-fighter with clear Meteor ancestry, under the designation P.228.

The three prototypes were equipped to virtually full operational standards, with SCR-720 (AI.Mk 10) radar in the nose and a small undernose bulge housing the scanner motor drive assembly. The aircraft carried IFF Mk 10, GEE Mk 3, an AYF radio altimeter and a 16-channel VHF radio. The aircraft met its required two-hour mission endurance at 30,000 ft (9144 m), though the underwing fuel tanks had to be strengthened when it was found that they tended to collapse at low level and high speed, or when the cannon were fired. The NF.Mk 11 was agile and was claimed by some to be capable of out-turning the F.Mk 8 in some regimes, though it was 3,000 lb (1360 kg) heavier, slightly slower (at 578 mph; 930 km/h all-out), and notably slower in the climb, despite its increased wing area.

The first production batch of 200 Meteor NF.Mk 11s was built to meet Contract 6/ACFT/3433 C.B.5(b), and consisted of WD585-WD634, WD640-WD689, WD696-WD745, and WD751-WD800. A second batch, of 111 aircraft, followed under Contract 6/ACFT/6141 C.B.5(b): WM143-WM192, WM221-WM270, and WM292-WM302. The first front-line delivery was WD585, which went to No. 256 Squadron in October 1950. The last was WM293, which went to No. 228 OCU.

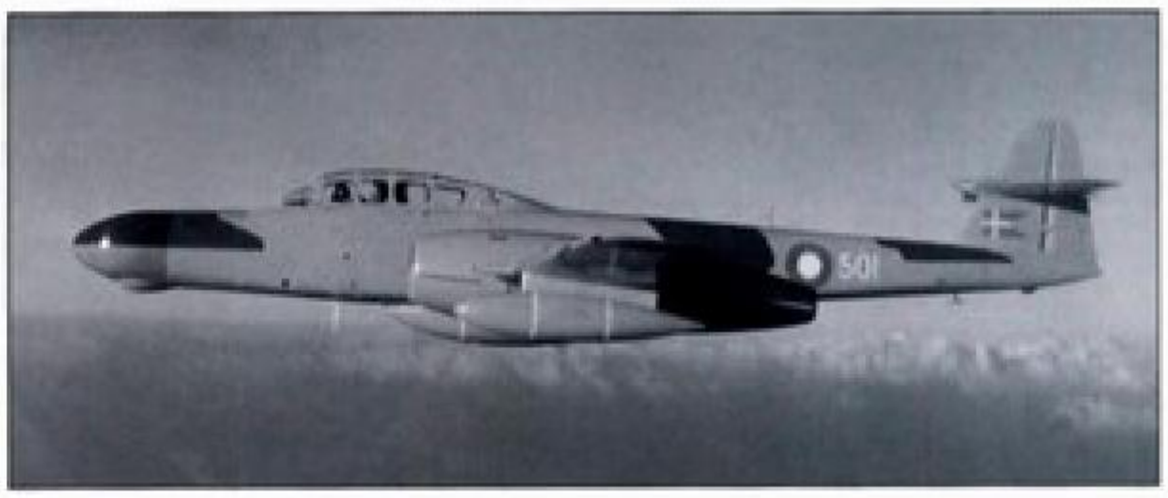
The Meteor NF.Mk 11 re-equipped four home-based all-weather fighter squadrons, No. 29 at Tangmere, No. 85 at West Malling, No. 141 at Coltishall and No. 264 at Linton-on-Ouse, together with three squadrons of Vampire NF.Mk 10s. One of the latter, No. 151 at Leuchars, subsequently re-equipped with the Meteor NF.Mk 11, and a further squadron, No. 125, reformed on 31 March 1955 before re-equipping with Venoms. No. 46 Squadron later received a few NF.Mk 11s while converting to the Gloster Javelin. The type went on to equip four squadrons within RAF


Meteor Mk 7 fuselage
Meteor Mk 8 empennage
SCR-720 (AI.Mk 10) radar
four 20-mm Hispano Mk V cannon
175-Imp gal (796-litre) fuel tank

Meteor NF.Mk 11

Germany, Nos 68 and 87 at Wahn and Nos 96 and 256 at Ahlhorn. Orders were increased to an eventual total of 338 aircraft. The NF.Mk 11 began to disappear from front-line service in 1954 and 1955, with the re-equipment of Nos 85, 141, 151 and 264 Squadrons. By 1953, Nos 85 and 141 Squadrons had a secondary role of coastal anti-shipping strike/strafe. No. 29 was the last Fighter Command NF.Mk 11 unit, retaining the type into November 1957, having reached a maximum strength of 24 aircraft in September. The RAF Germany units underwent a bout of renumbering after the August 1957 re-equipment of No. 87 Squadron with Javelins. No. 68 moved to Laarbruch to become No. 5, while Nos 96 and 256 moved to Geilenkirchen to become No. 3 and No. 11. These units re-equipped with Javelins in 1960, 1958 and 1959, respectively.

Meteor NF.Mk 11s were heavily engaged in trials, test and research work, and flew as radar, equipment and missile testbeds. Several were used in the development of the Fireflash missile, some of them flying from Woomera. One of the Meteor NF.Mk 11s used in Australia was allocated an RAAF serial, A77-3 (WM262), written off



Above: 501 was the first of 20 Mk 11s made available to the RDAF from RAF contracts, entering service with No. 723 Sqn in late 1952.

A number of Meteor Mk 11s were engaged in Fireflash AAM development trials, including WD745, WM372 (above) and the glossy white WM374 (below), both operated by the Fairey Company. The latter is seen over the Aberporth range with early Fireflashes mounted under each wingtip.

After a brief period in front-line service, a number of Armée de l'Air Meteor Mk 11s were taken over by the Centre d'Essais en Vol for trials work. One aircraft, serial unknown, test flew SFECMAS S-600 ramjets (below). NF11-1 (above) was among a number employed as radar test aircraft, in this case with what appears to be an Exocet missile shape fitted to its radome.

WD790, the 39th production NF.Mk 11, was the longest-serving radar research Meteor. Allocated to the Telecommunications Research Establishment in 1952, it was initially engaged in ECM trials. In 1958 it went to the Ferranti Flying Unit at Turnhouse (right) where it assisted in AI.Mk 23 radar development for the Lightning and, later, trials with Red Brick/Indigo Corkscrew radar for the Bloodhound and Thunderbird SAMs. Upon its return to what was by then known as the Royal Radar Establishment, it received the AIRPASS/AI.Mk 23 nosecone from Canberra B(I).Mk 8 WT327 in 1966/67 (above). Finally transferred to RAE Bedford, it was grounded in 1981.

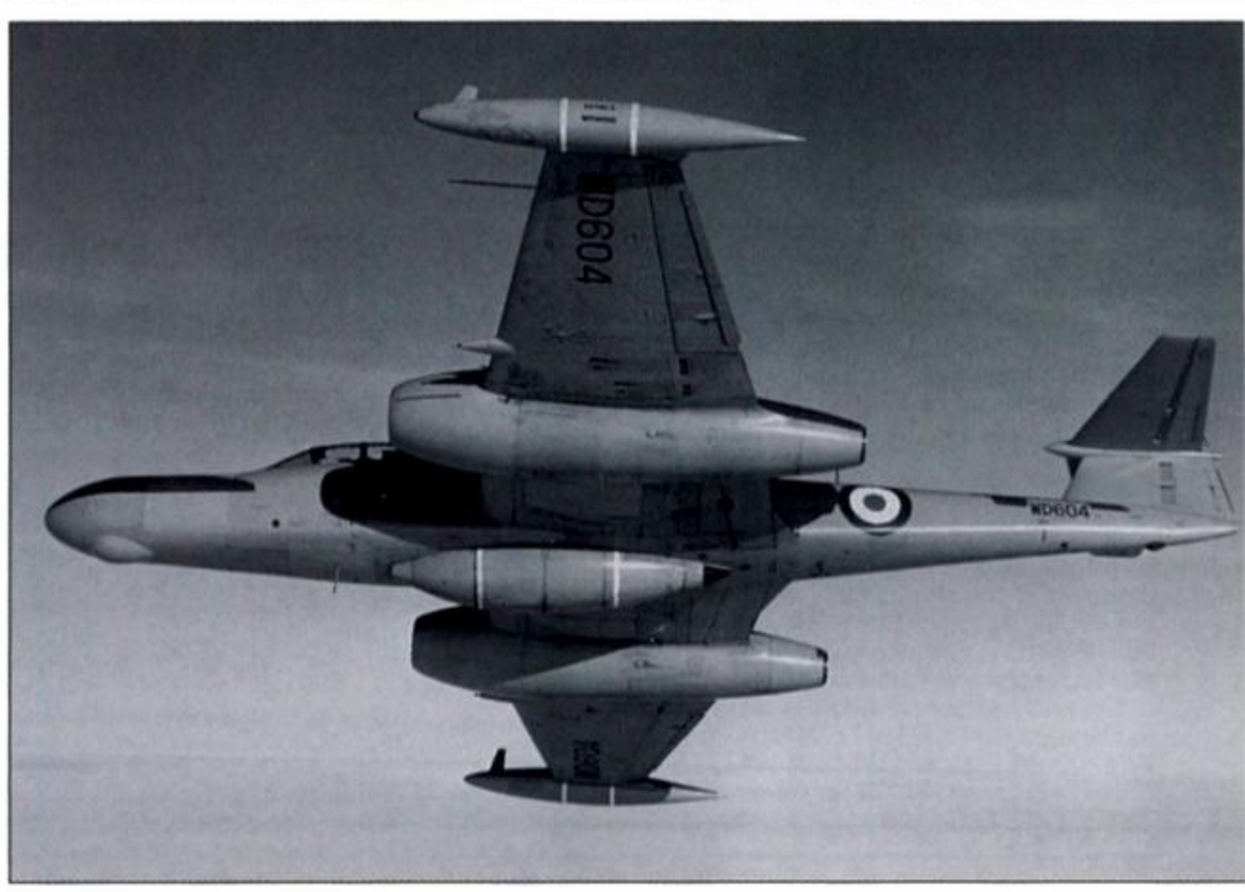
during trials of the Blue Boar missile.

A small number of customers purchased Meteor NF.Mk 11s, some of which were diverted from RAF contracts, while others were surplus ex-RAF aircraft. In the early days, there were even fewer alternatives to the night-fighting Meteor than there were to the single-seater, and many were exported. The first overseas customer was Denmark, which ordered 20 for service with No. 723 Squadron in early 1952; deliveries began in November and the unit was declared operational in December 1952. Serialled 501-520 in RDAF service, the Danish NF.Mk 11s were diverted from RAF contracts, and had been intended as WM384-WM403. They were retired from front-line use in June 1958, giving way to F-86Ds. Six were subsequently converted to virtual TT.Mk 20 standards between January and February 1959, re-entering service as H-504, H-508, H-512, H-517, H-518 and H-519. Four survivors were sold to a Swedish civil operator in 1962, as detailed in the TT.Mk 20 entry.

France ordered an initial batch of 16 NF.Mk 11s in December 1952, delivered between January and May 1953. These aircraft (NF11-10 to NF11-25) were diverted from RAF production, and had been planned as WM296-WM307 and WM368-WM371. A second batch of 16 was ordered in March 1953 and delivered between September 1954 and April 1955, being refurbished ex-RAF Meteor NF.Mk 11s drawn from a number of squadrons. Serialled NF11-26 to NF11-41, the aircraft included (in order of delivery) WD669, WD783, WM243, WD698, WD683, WD631, WD674, WD756, WD701, WM153, WM164, WM265, WM235, WD628, WD619 and one other. Also delivered directly to France were WM375-WM383, which are believed to have become NF11-1 to NF11-9 for the CEV.

The majority of the French NF.Mk 11s equipped the three squadrons of 30e Escadre de Chasse Tous Temps. EMICN 1/30 'Loire' was the OCU, with EC 2/30 'Camargue' and EC 3/30 'Lorraine' as the front-line squadrons. Vautour IINs began replacing the Meteors from 1957, though a large number of NF.Mk 11s continued to be used thereafter by the Centre d'Essais en Vol, the French air force test centre, as test and trials platforms. One aircraft flew with underwing SFECMAS S-600 ramjet engines, making it one of the few four-engined Meteors to fly. These aircraft remained in service long enough for a number of surplus TT.Mk 20s to be procured as spares ships in 1975.

The final overseas customer for the NF.Mk 11 was Belgium, which ordered 24 ex-RAF surplus aircraft in early 1957. They entered service with Nos 10 and 11 Squadrons at Beauvechain, and were replaced by CF-100s in 1959. Serialled EN-1 to EN-24 in Belgian service, the aircraft were WD590 (EN-19), WD594 (EN-16), WD596 (EN-20), WD602 (EN-13), WD622 (EN-15), WD661 (EN-18), WD724 (EN-14), WD726 (EN-1), WD727 (EN-7), WD728 (EN-4), WD729 (EN-5), WD730 (EN-6), WD731 (EN-8), WD732 (EN-9), WD733 (EN-10), WD735 (EN-11), WD736 (EN-12), WD741 (EN-21), WD760 (EN-17), WD763 (EN-22), WD775 (EN-2), WD777 (EN-3), WM221 (EN-23) and WM263 (EN-24).

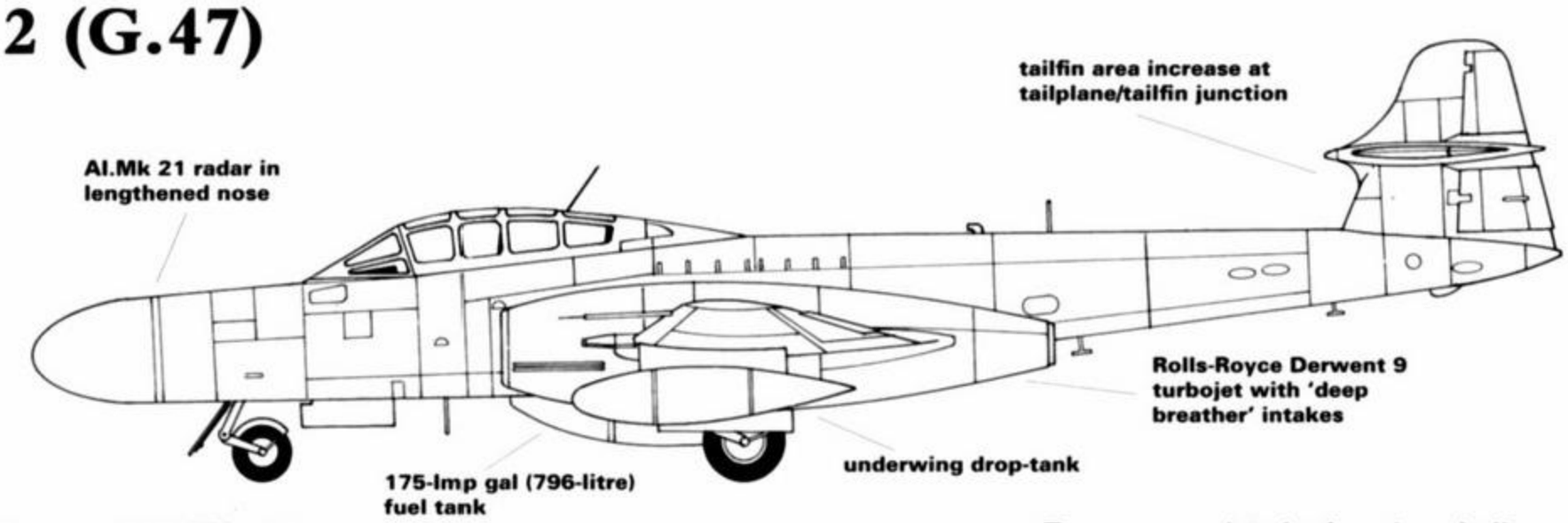


Despite the successful testing of wing-tip fuel tanks on the NF.Mk 11 prototype (WA546) and on WD604, seen here, they were not adopted on production Meteor night-fighters. The tanks were specially designed for the Meteor installation, with a capacity of 100 Imp gal (455 litres). A small vertical fin with 10° incidence, near the forward end of the tank, was designed to push it away from the aircraft once it was jettisoned.

Meteor NF.Mk 12 (G.47)

The NF.Mk 12 was an improved night-fighter featuring the American AI.Mk 21 (AN/APS-21) radar, supplied under MDAP, which featured a single PPI (Plan Position Indicator) display showing range and azimuth, together with an azimuth/elevation C-scope. The radar antenna could be 'pointed' by the navigator by using a joystick, instead of using a range of tilt-selectors. The new radar gave a range of about 15 miles (24 km) against another Meteor, or 20 miles (32 km) against larger targets, much more than double the range achieved using the AI.Mk 10. Experienced navigators were able to use AI.Mk 21 as a let-down aid, finding that runways and hangars would show up well.

The black boxes associated with the new AI.Mk 21 radar necessitated a longer nose, increasing the fuselage length by 17 in (43 cm) by comparison with the NF.Mk 11 and NF.Mk 13, taking the total to 49 ft 11 in (15.2 m). The installation was neater than that of the AI.Mk 10, and the aircraft needed no bulge on the bottom of the radome. The increased fuselage length was compensated for by the addition of extra area on the fin leading edge, provided by using fairings between the leading edge and the tailplane bullet fairing. With an empty weight of 12,292 lb (5575 kg), or a maximum operational weight of 17,223 lb (7812 kg), the NF.Mk 12 was slightly heavier than the NF.Mk 11, so to compensate the new version was fitted with 3,800-lb st (16.90-kN) Derwent 9 engines. All NF.Mk 12s therefore had the larger-diameter 'deep breather' intakes. The Derwent 9 was the most powerful engine fitted to a production Meteor variant, and was used only by the NF.Mk 12 and NF.Mk 14. The limiting Mach number was raised from M0.79 to M0.81, and wing structure was strengthened to permit higher indicated airspeeds.


tailfin area increase at tailplane/tailfin junction
AI.Mk 21 radar in lengthened nose
Rolls-Royce Derwent 9 turbojet with 'deep breather' intakes
underwing drop-tank
175-Imp gal (796-litre) fuel tank

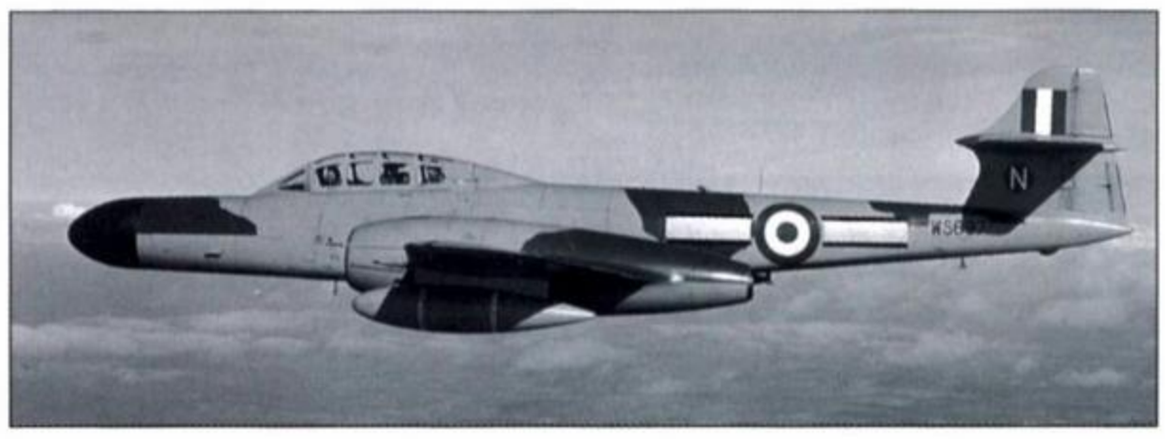
Meteor NF.Mk 12

The aerodynamic prototype for the NF.Mk 12 was NF.Mk 11 WD687, which received most of the modifications applied to the production version. The NF.Mk 12's US radar effectively prevented any exports of the type. Only 97 production NF.Mk 12s were built, with WS590 making the type's maiden flight on 21 April 1953, in the hands of Squadron Leader Eric Franklin.

The NF.Mk 12s were built in response to Contract 6/ACFT/6412 C.B.5(b), and consisted of WS590-WS639, WS658-WS700, and WS715-WS721.

NF.Mk 12 deliveries began in late 1953, to No. 238 OCU at North Luffenham. No. 238 OCU was responsible for training navigators and radar operators for all AI.Mk 21-equipped fighters, including the Venom NF.Mk 3 and Fleet Air Arm Sea Venom FAW.Mk 21s and FAW.Mk 22s. The first front-line squadron to receive NF.Mk 12s was No. 85 at West Malling, in September 1953. Most front-line squadrons operated a mix of NF.Mk 12s and NF.Mk 14s.

To accommodate its American-built radar, the NF.Mk 12 required a longer radome, which in turn necessitated an increase in fin area, accomplished by fitting fairings between the fin leading edge and tailplane bullet fairing. WS697/'N' was a No. 25 Sqn machine.



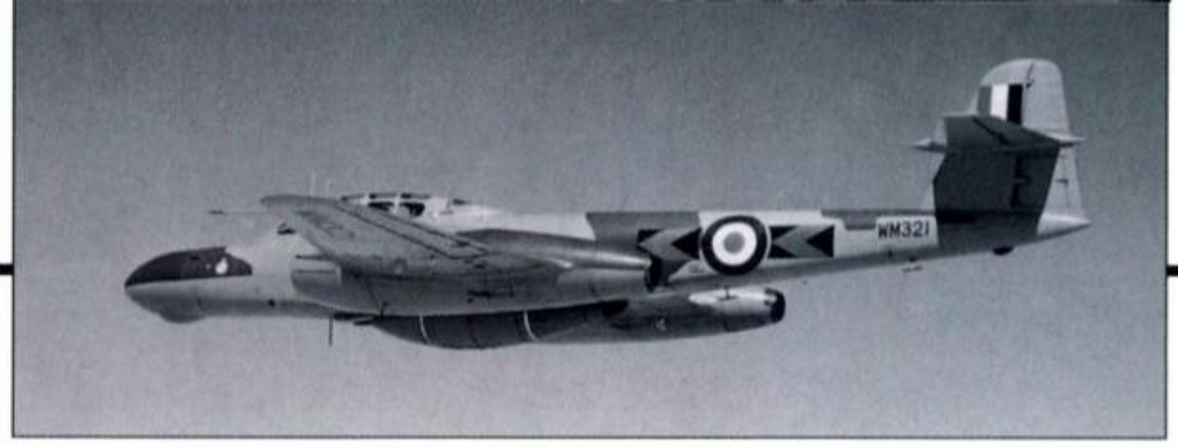
Meteor NF.Mk 13 (G.47)

The Meteor NF.Mk 13 was a minimum-change, tropicalised version of the basic NF.Mk 11, intended principally for service in the Middle East, where aircraft like the Mosquito NF.Mk 30 were particularly ill-suited because of their temperature- and climate-sensitive bonded plywood construction. It pre-dated the more advanced NF.Mk 12 by several months. The prototype, WM308, made its maiden flight on 21 December 1952 (or 23 December, according to some sources), in the hands of J. O. Lancaster.

The NF.Mk 13 had a refined navigation suite in order to operate over featureless desert terrain and in areas with limited ground-based radar coverage and sparse ground-based navaids. It had as standard the distance-measuring and direction-finding equipment that was sometimes fitted to some NF.Mk 11s. The DF loop antenna and associated equipment increased AUW by 450 lb (204 kg), and the type was correspondingly slower than the unmodified NF.Mk 11. A DF loop antenna was fitted in the rearmost part of the cockpit canopy behind the navigator's position. DME antennas were fitted above and below the outer wing panels. The aircraft also had additional cold air ram intakes on the fuselage immediately forward of the ventral tank, serving the cabin and equipment bay cooling equipment. The last NF.Mk 13s were fitted with increased-area flaps outboard of the engine nacelles. Generally, the NF.Mk 13 looked externally much like the NF.Mk 11, with the same short radome and underslung actuator bulge.

Only 40 Meteor NF.Mk 13s were built, all to Contract 6/ACFT/6141 C.B.5(b), serialled WM308-WM341 and WM362-WM367. The aircraft equipped No. 39 Squadron at Fayid and No. 219 Squadron at Kabrit, though some were diverted to export customers without ever seeing RAF service. No. 219 Squadron disbanded when the RAF withdrew from the Canal Zone, but No. 39 moved to Malta in 1954, remaining there until 1958.

Egypt, Israel and Syria each received six Meteor NF.Mk 13s. Most Israeli aircraft had seen RAF service, but the Egyptian and Syrian aircraft were brand new. Egypt took delivery of six ex-RAF NF.Mk 13s, WM325, WM326, WM328, WM338, WM340 and WM362, reserialled 1427, 1428, 1429, 1430, 1431 and 1432, respectively. They were delivered in 1955, but the Egyptian air force found it difficult to get them operational, lacking the necessary trained personnel or support equipment. The aircraft initially served with No. 4 Navigator Training Fighter Training Unit, and later with No. 10 Squadron at Almaza. The Syrian aircraft were WM330, WM332, WM333, WM336, WM337, and WM341, respectively reserialled 473, 471, 476, 472, 474 and 475. They were delivered in June and July 1954.



Above: Based at Kabrit, Egypt, No. 219 Sqn was one of two RAF squadrons to fly NF.Mk 13s. Extra antennas on the Mk 13's wings distinguished this variant from the NF.Mk 11, from which it was derived. Late production examples also had increased-area flaps.

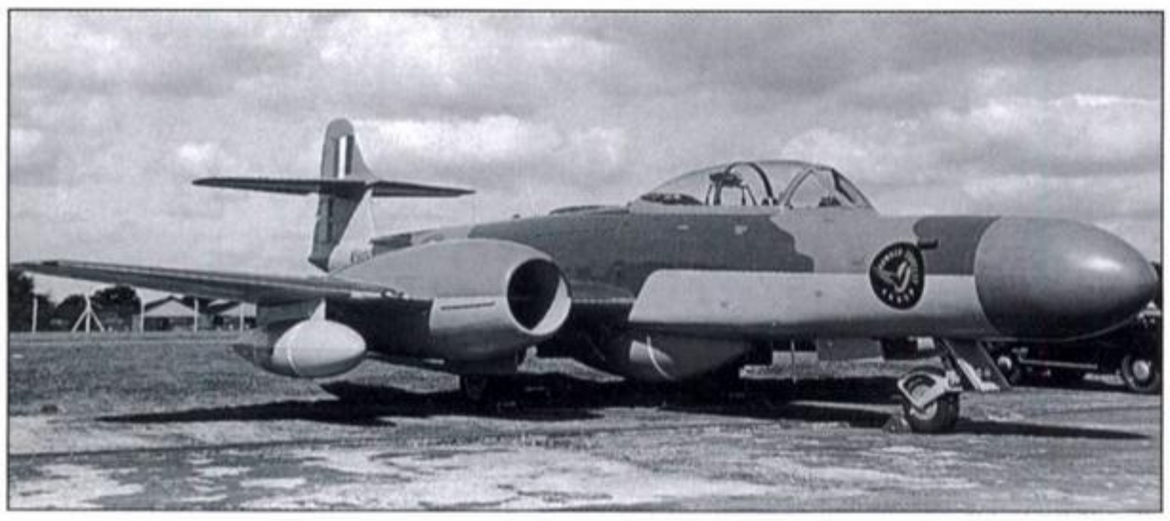
Several of Israel's NF.Mk 13s had previously seen front-line service with the RAF, before being delivered to the IDF/AF between September 1956 and March 1958. Three arrived before the Suez crisis, in which they played a minor part. Originally serialled WM309, WM312, WM320, WM334, WM335 and WM366, the aircraft became IDF/AF 50 (4X-FND/2159), 55 (4X-FNC/2158), 57 (4X-FNE/4X-BET/2160), 51 (4X-FNB/2157), 59 (4X-FNF/2161) and 52 (4X-FNA/2156). The Israeli NF.Mk 13s briefly filled the gap pending the arrival of the Vautour, serving with No. 119 Squadron under Yehuash 'Chato' Tsidon. With his navigator Alyasheeb Brosh, Tsidon scored an air-to-air kill, shooting down an Egyptian Ilyushin Il-12. The Meteor NF.Mk 13s were retired from the advanced NF training role in 1964, with the exception of 4X-BET, which served with IAI's Flight Test Centre in 1967.

Two ex-RAF Meteor NF.Mk 13s (WM364 and WM365) were also delivered to the Armée de l'Air in 1956, serving with the CEV as NF-F364 and NF-F365. They augmented similarly bought NF.Mk 14s, and the survivors of 41 NF.Mk 11s once used as night-fighters by the Armée de l'Air's EC 30.

Below: Israel received six Meteor NF.Mk 13s, five of which had seen service with either the RAF or test organisations in the UK. 4X-FNB, nearest the camera, was the former WM334, sold in April 1956.

Meteor NF.Mk 14 (G.47)

The Meteor NF.Mk 14 was the ultimate Meteor night-fighter, combining the advanced AI.Mk 21 radar and the more powerful engines and structural improvements of the NF.Mk 12 with further refinements that, albeit, were more obvious than significant. The aircraft weighed 12,620 lb (5724 kg) empty, or 21,200 lb (9616 kg) fully laden with maximum fuel, making it the heaviest Meteor variant, and performance suffered accordingly. By the time the NF.Mk 14 entered service, it was virtually incapable of intercepting the latest jet bombers and, during exercises, Canberra crews were often told to limit their ceiling to 'give the fighter boys a chance'. The most immediately apparent of the NF.Mk 14's unique modifications was a new rearward-sliding, electrically-actuated bubble canopy, combined with a less raked windscreen. The crew could have ejected through the new canopy – had they been provided with ejection seats. The aircraft was also fitted with spring-tab ailerons and an autostabiliser, which would have improved high-speed handling – had the NF.Mk 14 been capable of exceeding an asthmatic 576 mph (926 km/h). The nose was lengthened by a further 17 in (43 cm), taking total length to 51 ft 4 in (15.65 m).



Above: The last production Meteor, WS848, is seen here around the time of the 1954 SBAC air show with a Hawker Siddeley logo applied to its elongated nose.

Below: The much improved visibility afforded by the NF.Mk 14's clear-view canopy and the length of its AI.Mk 21-equipped nose are evident in this view of a No. 46 Sqn aircraft, WS830/'H'.

The prototype NF.Mk 14 was converted from an NF.Mk 11, WM261, and made its first flight in its new configuration on 23 October 1953. Flight Lieutenant W. H. 'Bill' Else was the pilot. Only 100 production NF.Mk 14s were built, all in response to Contract 6/ACFT/6412 C.B.5(b). Their serials ran from WS722-WS760, WS774-WS812 and WS827-WS848. WS722 was the first NF.Mk 14 delivered to a front-line unit, going to No. 153 Squadron. Photos of the new version were not released until May 1954, when the type was already in widespread front-line service with Nos 25 and 85 Squadrons.

Most Fighter Command all-weather fighter squadrons traded NF.Mk 11s for a mix of NF.Mk 12s and NF.Mk 14s, and few units used only NF.Mk 14s. The NF.Mk 14 equipped Nos 25, 33, 46, 60, 64, 72, 85, 152, 153 and 264 Squadrons.

One of the only front-line squadrons not to use a mix of NF.Mk 12s and NF.Mk 14s was No. 60, the last RAF Meteor Squadron to form. After training at Leeming (with NF.Mk 12s and 14s), the squadron's aircrew ferried a batch of specially modified and newly refurbished NF.Mk 14s to their base at RAF Tengah, Singapore. These aircraft were externally recognisable through their rare camouflage scheme of silver undersides and low upper/lower surface camouflage demarcation. The squadron flew the NF.Mk 14 from October 1959 until August 1961, when it re-equipped with Gloster Javelins. WS787 made the type's last front-line flight on 17 August 1961, in the hands of Squadron Leader P. G. Middleton and his navigator, Flight Lieutenant J. W. Betts. The aircraft was then retired to serve as Tengah's gate-guard. Thereafter, the Meteor NF.Mk 14 served only in second-line roles, with the A&AEE, ETPS and RAE, and, as the NF(T).Mk 14, with Flying Training Command.

Two ex-RAF NF.Mk 14s (WS747 and WS796) were delivered to the French CEV in 1955, becoming NF14-747 and NF14-796.

One final 'almost export customer' was the Biafran air force, which attempted to obtain Meteor night-fighters from a number of sources. These included ex-Swedish (and previously ex-Danish) target-tugs and two NF.Mk 14s, WS804 of the RAE (which became G-AXNE of 'Enterprise Films') and Rolls-Royce's G-ASLW (ex-WS829). These aircraft were registered to Target Towing Aircraft Ltd of Blackbushe, and were then delivered (via Senegal) in 1969, though one was lost en route, ditching between Madeira and Cape Verde. The other (G-AXNE) probably got no further than Bissau, where it made a forced landing and was reportedly abandoned.

The NF.Mk 14 prototype, the former Mk 11 WM261, was sold to Ferranti at Turnhouse, Edinburgh after serving with the A&AEE. Registered G-ARCX, it served as a company hack, though it was flown very little.

Powerplant
The Meteor Mk 14 inherited its Derwent 9 engines from the Mk 12 night-fighter variant, though these 3,800-lb (16.9-kN) thrust engines could only push the (by now) considerably heavier NF.Mk 14 (weighing almost 9½ tons fully loaded) along at 576 mph (927 km/h).

Armament
Like all the armed Meteor variants before it, the NF.Mk 14 was equipped with four Hispano 20-mm cannon, though these were wing-mounted in the night-fighter variants. The Mk V cannon in the Mk 14 were each fed with 160 rounds.

WS800, the 64th of 100 Meteor NF.Mk 14s produced by Armstrong Whitworth, was initially issued to No. 152 Sqn at RAF Wattisham in mid-1954. Upon the squadron's disbandment in 1958, '800 was passed to No. 60 Sqn in Singapore, becoming the CO's mount. No. 60 was destined to be the RAF's last operational Meteor unit, disposing of its remaining examples in September 1961, as it re-equipped with Javelins. WS800 was struck off charge on 7 August 1961.

Armstrong Whitworth (Gloster) Meteor NF.Mk 14 No. 60 Sqn Far East Air Force Tengah, 1960

AI radar
The definitive Meteor night-fighter radar was APQ-43 (AI.Mk 21), housed in an enlarged nose radome some 17 in (43 cm) longer than that of the NF.Mk 11, bringing total fuselage length to 51 ft 4 in (15.65 m).

Camouflage
While earlier Meteor night-fighters had been finished in overall Dark Sea Grey with a disruptive Dark Green camouflage pattern on their upper surfaces, the Mk 14 introduced a variation: Medium Sea Grey replaced the darker shade on the aircraft's undersides. No. 60 Sqn's aircraft were unique for another reason, in that their camouflage extended over a larger area of fuselage.

Airframe
Derived from the T.Mk 7, the Meteor night-fighter family shared the trainer's full-span wing but featured a new empennage derived from that fitted to the F.Mk 8 and a suitably lengthened nose accommodating the AI radar set. Cabin pressurisation was a new feature.

Markings
No. 60 Sqn's badge – officially, 'a markhor's head affrontée' – appears with a squadron leader's pennant on the nose of this, the CO's aircraft. The markhor's (a type of goat) head also appears in front of alternate black and white stripes on the tailfin. White lightning bolts are applied, on a black background, in the bars either side of the Type 'D' roundels and on the front outboard corner of the wing drop-tanks.

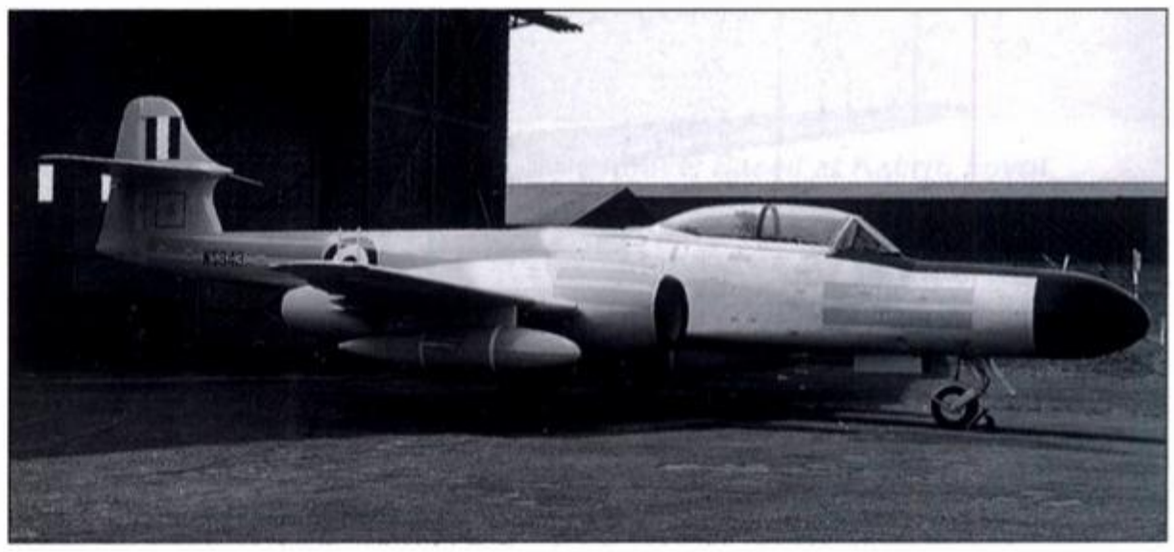
Cockpit canopy
Though its lighter, electrically-operated, clear-view bubble canopy would have made the use of ejection seats feasible, the NF.Mk 14 was not so-equipped, even though the F.Mk 8 had introduced the 'bang seat' in the Meteor some five years previously.

External fuel
As a means of improving their poor endurance, Meteor Mk 14s routinely carried three external fuel tanks totalling 375 Imp gal (1705 litres).

Meteor NF(T).Mk 14

A handful of surplus NF.Mk 14s were pressed into service as high-speed, fast-jet navigator training aircraft, bridging the gap between ageing Valettas and Varsities and the Hawker Siddeley Dominie, which entered service in 1965. They took over the role from tired Vampire NF.Mk 10s with No. 2 ANS at Thorney Island in 1959, transferring to No. 1 ANS at Stradishall in early 1962, when Thorney Island began to train only navigators for 'heavies'. The Meteors were modified for their new navigator training role, principally in having all armament and radar removed, though they retained cannon stub fairings on the wings and black, unpainted radomes. The aircraft were also painted in a new colour scheme, with low demarcation lines between the top-surface camouflage and the high-speed silver undersides, like the final NF.Mk 14s delivered to No. 60 Squadron. During the early 1960s, the aircraft were repainted silver overall, with high-visibility Dayglo strips on the nose, tail and outer wings. The NF(T).Mk 14s received a UHF radio, a Rebecca Mk 4 homing system and other minor modifications. Fourteen known NF(T).Mk 14 conversions were WS726, WS737, WS739, WS744, WS760, WS774, WS788, WS792, WS797, WS802, WS807, WS840, WS842 and WS843. A handful served into 1966, although most previous histories have suggested that the type was withdrawn in autumn 1965.

Some believed that the NF(T).Mk 14 should have been retained for pre-operational conversion fast-jet navigator experience, since it allowed the potential student navigator to experience a representative fast jet environment, whereas in the Dominie he sat in an enclosed cabin, in what could have been a shirtsleeve environment. In the NF(T).Mk 14 the student navigator was also very much 'on his own', sitting behind a staff pilot, with no colleagues and no friendly navigation instructor.



Patches of Dayglo paint on the fuselage and wings of NF(T).Mk 14s made these training aircraft more visible to other air traffic. Though they retained black radomes and gun fairings, these converted night-fighters were unarmed and without radar. WS843, photographed at RAF St Athan in September 1971, later joined the RAF Museum collection and in 1998 was displayed at the Aerospace Museum, Cosford.

Meteor U.Mk 15

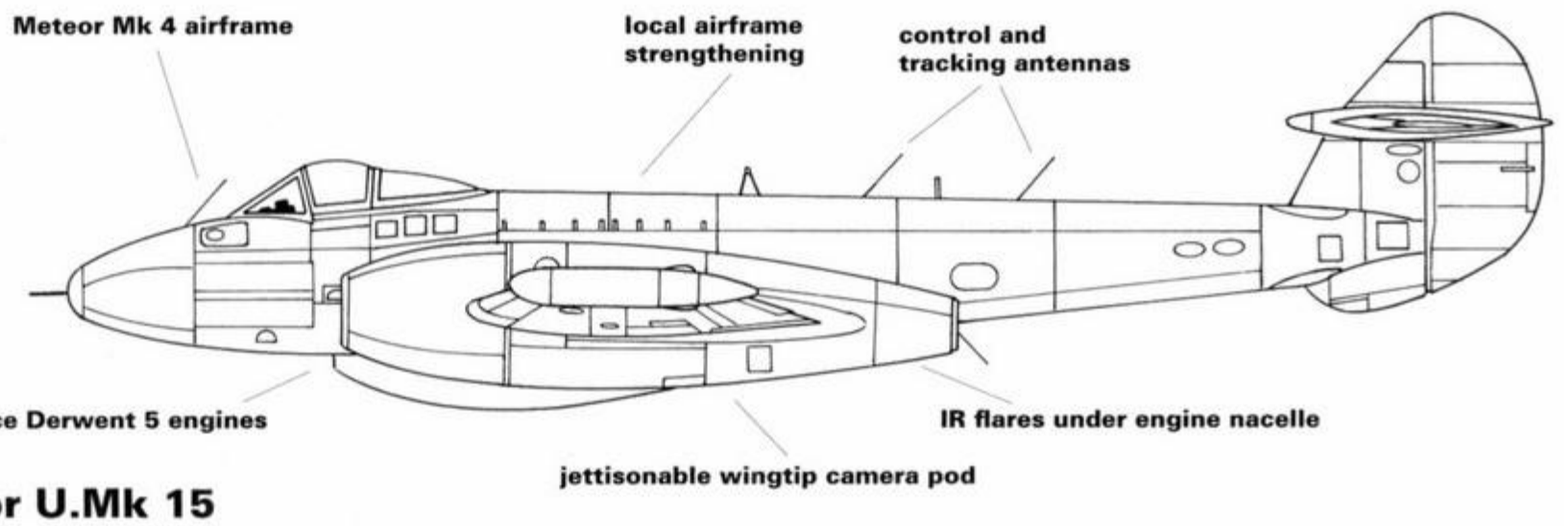
The development of advanced air-to-air weapons prompted the belief that routine fighter pilot training would have to include the use of drone targets, which spurred development of the U.Mk 15. Even in the 1950s, such a use of redundant and obsolete fighters was prohibitively expensive, and the Meteor drones found themselves used primarily for trials of new missile systems (especially SAMs) and often used towed IR-decoy flares to avoid destruction of the drone itself. The aircraft were not regarded as being entirely expendable, and were frequently flown manned.

The availability of large numbers of obsolescent Meteor F.Mk 4s made the type an obvious choice as Britain's first jet target drone, and one which worked out cheaper than newly-built Jindivik drones. The smaller de Havilland Vampire F.Mk 1 was clearly less suitable as a drone, though its single-engined configuration was attractive. Initial drone tests were conducted at the RAE, Farnborough, using a T.Mk 7 fitted with an Ultra Ltd Throttle Control Unit. This aircraft was remotely controlled in flight for the first time on 2 September 1954, with Flight Lieutenant Pennie in the front seat, taking hands and feet off the controls, watched by Gordon Hamm of Ultra. A fully remote take-off was made on 17 January 1955, with a Mr Summerhayes watching the same pilot. The first U.Mk 15, RA421, produced by Flight Refuelling Ltd and the RAE, made an automatic (but manned) take-off on 11 March 1955, and a fully automatic landing at the end of the month. This was hard enough to drive the undercarriage through the wing, and necessitated repairs to the aircraft and a rethink of the control system. In its production form, the U.Mk 15 was controlled by a Master Controller, who 'flew' the aircraft in flight, and supervised operators manning fixed optical sights who controlled the aircraft (separately) in pitch and azimuth during take-off and landing.

The U.Mk 15 was fitted with wingtip camera pods, each containing two WRETAR cameras, one looking above the wing and one below, each with a 180° FoV. The wingtips and pods were jettisonable, and fitted with recovery parachutes, buoyancy aids and homing beacons, allowing the trial film to be recovered even if the drone had to be destroyed. Three IR flares were fitted below each engine nacelle, to give missiles a source on which to home. They could be fired singly or as a cluster.

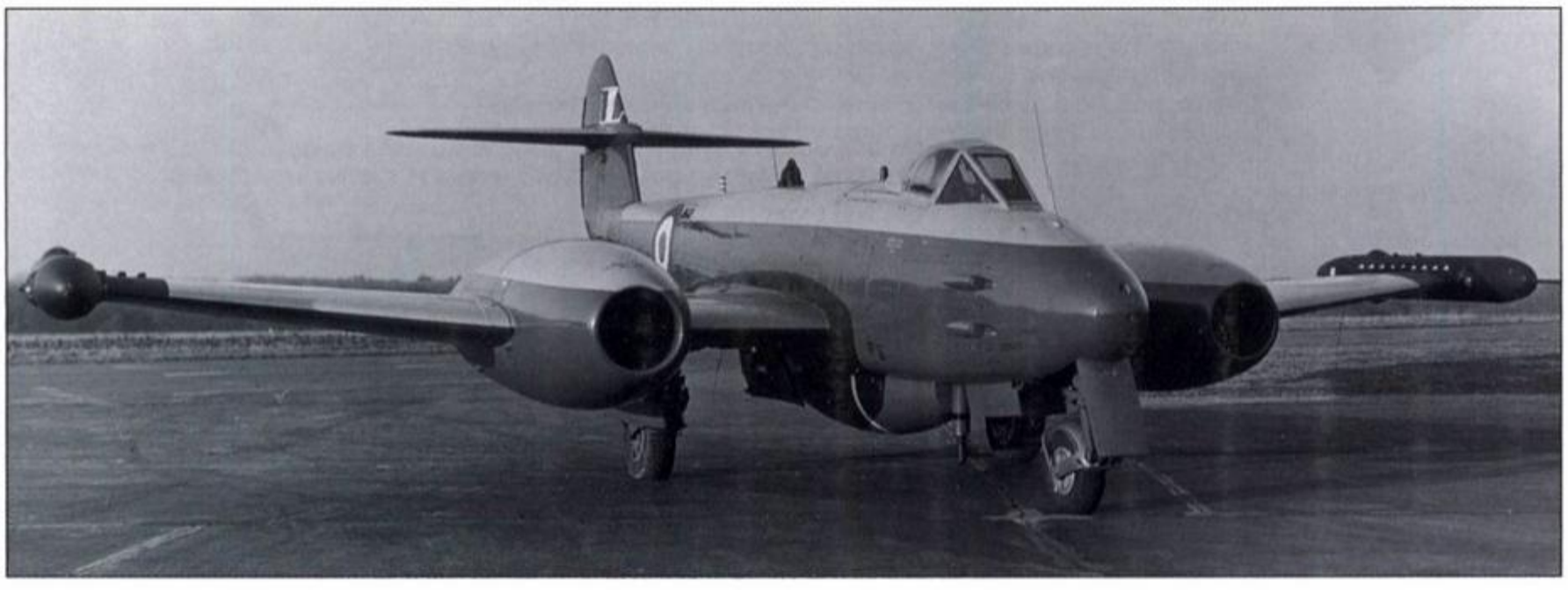
Although most sources suggest that Flight Refuelling converted 92 F.Mk 4s to U.Mk 15 standards, only 91 can be identified by serial number, looking through individual aircraft record cards. These were EE521, 524, RA367, 371, 373, 375, 387, 397, 398, 415, 417, 420, 421, 430, 432, 433, 438, 439, 441, 442, 454, 457, 473, 479, VT104, 105, 106, 107, 110, 112, 113, 118, 130, 135, 139, 142, 168, 175, 177, 179, 184, 187, 191, 192, 196, 197, 219, 220, 222, 226, 230, 243, 256, 259, 262, 268, 270, 282, 286, 289, 291, 294, 310, 316, 319, 329, 330, 332, 334, 338, VW258, 266, 273, 275, 276, 280, 285, 293, 299, 303, 308, 781, 791, VZ386, 389, 401, 403, 407, 414, 415, 417.

The biggest user of the U.Mk 15 was the Weapons Research Establishment (WRE) at Woomera. The U.Mk 15s delivered to the WRE were operated by the RAAF in support of UK Ministry of Supply trials, and as such carried RAAF roundels while retaining their RAF serials. The number of U.Mk 15s delivered to the WRE from 1957 has been variously reported as 59, 60 or 61. Some 58 can be definitely identified by serial number, starting with EE524 in December 1954. The remainder were used by the RAE at Llanbedr, for drone development work and for missile trials over the Aberporth range. A number (variously quoted as seven, 10 or 14, but certainly including RA375, RA387, VT104, VT107, VT110, VT243, VT282, VT291, VT310, VW258, VW276, VZ415 and VZ417) were used by the Royal Navy's No. 728B Squadron at Hal Far, Malta from 1959, in support of Seaslug and Thunderbird SAM trials. The survivors (including RA375) returned to RAE use in 1960-1961. VT196 made the U.Mk 15's last flight on 9 February 1963.


Meteor Mk 4 airframe
local airframe strengthening
control and tracking antennas
Rolls-Royce Derwent 5 engines
IR flares under engine nacelle
jettisonable wingtip camera pod

Meteor U.Mk 15

Here a U.Mk 15 is prepared for another flight over the Aberporth range, from Llanbedr. Note the various antennas visible on the aircraft, the single remaining gun port and ventral fuel tank.



RA420 was the first of over 90 Meteor U.Mk 15 conversions. Completed as an F.Mk 4 in 1947, the aircraft was initially allocated to the A&AEE and later to Rolls-Royce for trials, before delivery to Flight Refuelling Ltd for conversion to Mk 15 standard in 1953. It first flew, manned, two years later and was delivered to Llanbedr in 1960.

Meteor U.Mk 16/D.Mk 16

Although never frittered away extravagantly, the U.Mk 15s were quickly expended, and it was decided that they would be followed by a later Meteor drone, with equipment refinements and enhanced performance. The U.Mk 16 designation was applied to drone conversions of the later Meteor F.Mk 8. Redundant Meteor F.Mk 8 airframes were plentiful, following dramatic cuts in the RAF's front-line strength and the replacement of Meteors by Hunters in those squadrons which survived the axe. The Meteor U.Mk 16 introduced an Elliott Type B.4 autopilot and a new lengthened nose, accommodating many of the new drone systems, and the test cameras were housed in slimmer wingtip pods. Meteor drones were stripped of their cannon armament and were completely rewired, with electrical junction boxes installed in the former gun bays for ease and speed of access. New generators were installed, pushing power output from 4 to 12 kW.

The first U.Mk 16 prototype was WA775, which first flew after conversion on 22 October 1956, originally with a standard 'short' nose and the larger U.Mk 15-type wingtip pods. A number of 'prototype' U.Mk 16s were used for development work, including WE934, WH284, WH320, WH369, WH381 (intended as the prototype of a long range drone, with extra fuel), and WH420. The first 'production' U.Mk 16 was WK926, converted in 1960, and delivered to Llanbedr on 18 July 1960.

Most sources suggest that some 108 F.Mk 8s were converted to U.Mk 16 standards, but this is based on a figure published in the early 1960s, when the conversion programme was far from complete. This in turn was probably based on an over-pedantic interpretation of a Flight Refuelling press release which anticipated the production of (about) 200 Meteor drones, combined with another figure of 92 U.Mk 15s (which seems to have been equally erroneous, as we have seen). Every figure released has been different, and when the programme finally came to an end, some sources suggested that 250 U.Mk 16s had been produced. Some aircraft which were expected to be used for spares ended up undergoing drone conversion (especially at the end of the programme), while others were not used.

As far as can be ascertained from individual aircraft histories, the following 91 Meteor F.Mk 8s actually underwent conversion to U.Mk 16 configuration: VZ445, VZ485, VZ506, VZ508, VZ514, VZ551, WA756, WA775, WA842, WA982, WA991, WE867, WE872, WE915, WE932, WE934, WE960, WE962, WF706, WF707, WF711, WF716, WF741, WF743, WF751, WF755, WF756, WH258, WH284, WH286, WH309, WH320, WH344, WH349, WH359, WH365, WH369, WH372, WH373, WH376, WH381, WH420, WH453, WH499, WH500, WH505, WH506, WH509, WK648, WK693, WK709, WK717, WK729, WK738, WK743, WK783, WK784, WK789, WK790, WK793, WK795, WK797, WK799, WK800 (redesignated from U.Mk 21A), WK807, WK812, WK852, WK855, WK859, WK870, WK877, WK883, WK885, WK911, WK925, WK926, WK932, WK941, WK942, WK949, WK971, WK980, WK989, WK993, WK994, WL110, WL124, WL127, WL160, WL162 and WL163.

About four U.Mk 16s were used by the Royal Navy's No. 728B Squadron, alongside a larger number of U.Mk 15s. Known Navy U.Mk 16s were WE932, WF716, WK870 and WL127.

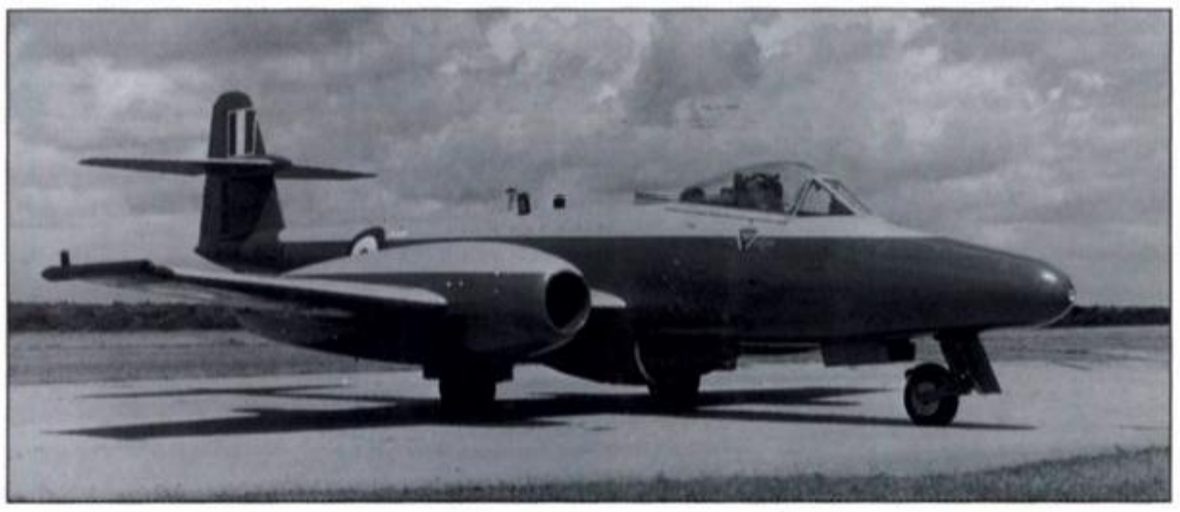
A number of attempts were made to replace the Meteor U.Mk 16. Small numbers of Canberra U.Mk 10s and D.Mk 14s were produced, though the demands on redundant Canberra airframes (for export and for other second-line uses) were such that a full-scale Canberra drone programme was impossible. Thus, the Meteor conversion programme rumbled on for much longer than had once been expected. WH286 was the last conversion, emerging from Flight Refuelling's Tarrant Rushton works in 1975, but it was one of several drones produced during the early 1970s. A Sea Vixen drone conversion programme began later, but was abandoned following the conversion of a handful of prototypes. Unfortunately, the Sea Vixen was expensive to operate and its handling characteristics were inadequate for unmanned operation. Surplus Lightnings were briefly considered, but were felt to offer unacceptably difficult handling characteristics for unmanned operation. The Meteor F.Mk 8-based drone should properly be referred to as D.Mk 16s today, the prefix U for unmanned having been replaced by D for Drone during the 1960s. The final three D.Mk 16s in use were WH320 (expended on 15 August 1979), WH453 (in storage by September 1991) and WK800. The survivors were fitted with Radar Vector Miss Distance Indicator equipment in 1988.

The last Meteor drone in service, WK800, is no longer used as a target, but has instead been modified to allow it to be used for the training of Jindivik drone controllers. Flown manned, but under ground control, the Meteor has been fitted with Jindivik telemetry and control systems and the pilot can 'take over' from the team of controllers simply by overriding their inputs, or by using autopilot and radio control disengage buttons on the stick and rudder. The aircraft has also been used to help develop a new Advanced Ground Station for more automated control of the Jindiviks.

U.Mk 16s WE960 and WK797 were despatched to Australia, where they were modified by Fairey at Bankstown and redesignated as U.Mk 21s. All other U.Mk 21s (eight aircraft) were converted by Flight Refuelling from non-drone ex-RAF F.Mk 8s, prior to being shipped to Australia. Ex-RAAF F.Mk 8s converted by Fairey were known as U.Mk 21As.

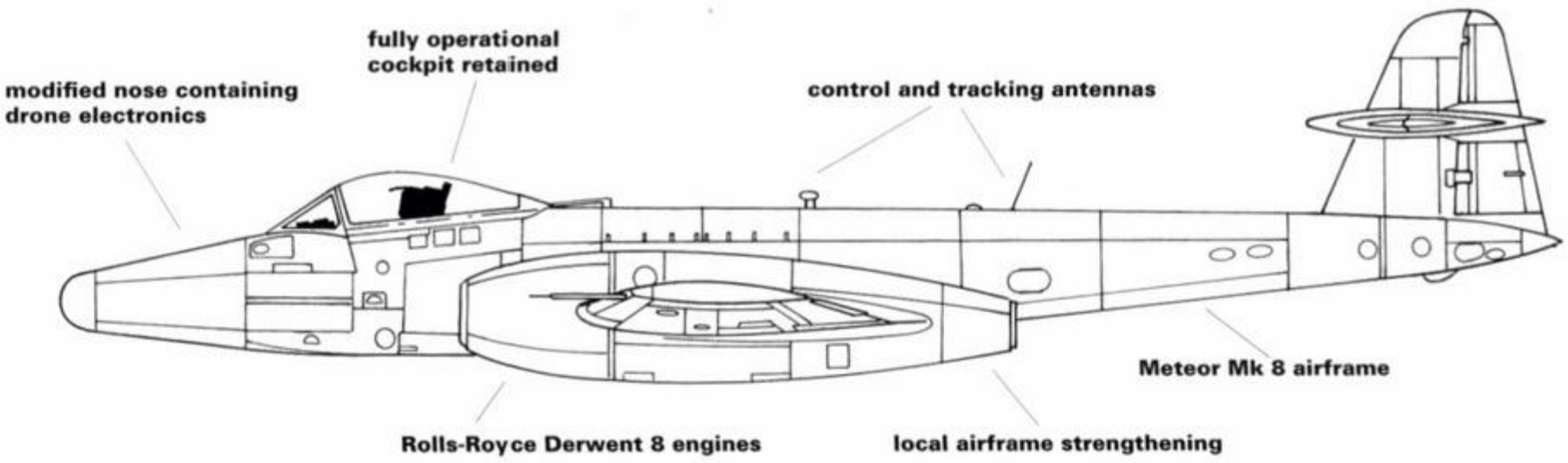
A further 31-34 F.Mk 8s were delivered to Flight Refuelling for use as spares ships, and were not actually converted to drone configuration. The aircraft assigned to the Ministry of Aviation for spares use were VZ439, VZ448, VZ458, VZ462, VZ513, VZ520, VZ530, VZ554, WA781, WA850, WA984, WE881, WE919, WE924, WE925, WE946, WF646, WF681, WF685, WF741, WH281, WH469?, WK660, WK675, WK716, WK721, WK731, WK737, WK744, WL111, and WL134 (may subsequently have undergone conversion). WK745, 746 and 747 were allocated to the U.Mk 16 programme, but it is hard to establish whether they were used for spares, or as drones.

Above: WH453 was one of the last two Meteor drones assigned to the Defence Evaluation & Research Agency's Ranges Division at Llanbedr. By late 1991 it was in open storage. In 1999 its companion, WK800 (a former RAAF U.Mk 21A) was still in service as a trainer.



Above: As well as a reshaped nosecone containing the electronic equipment required for its new role, this U.Mk 16 sports a variety of antennas necessary for the equipment used to control and track the aircraft on a range.

Left: An unmanned U.Mk 16 – WH344/'O' – is seen on an air test prior to delivery to Llanbedr in June 1961. While some U.Mk 15 aircraft were not able to be piloted, all Mk 16s could be flown remotely, with or without a pilot aboard to monitor systems, or flown as a normal piloted aircraft.


fully operational cockpit retained
modified nose containing drone electronics
control and tracking antennas
Meteor Mk 8 airframe
Rolls-Royce Derwent 8 engines
local airframe strengthening

Meteor U.Mk 16

Meteor 'U.Mks 17-20'

Some sources in the 1960s described the Meteor U.Mks 17, 18, 19 and 20 as being proposed drone conversions of the NF.Mks 11, 12, 13 and 14, respectively. Such designations would have been unlikely to have been formally allocated before a production contract was placed (today, a new mark number cannot be allocated until a Military Aircraft Release to Service is issued). Moreover, the suspicion must be that the designations are speculative, and represent an attempt to logically fill the gap between the U.Mk 16 and the U.Mk 21. In fact, the Mk 20 designation was used for the TT.Mk 20, as will be seen, although this had not become known when the speculative U.Mk 20 designation was published. The fact that the sequence 'started again' with the Mk 20 was by no means unusual at the time, when FAA and/or Australian versions of RAF aircraft routinely began with the Mk 20. Examples included the Canberra B.Mk 20, the Vampire F.Mk 20, the Sea Hornet, Sea Venom, and the original DH.110.

Meteor TT.Mk 20

A number of single-seat and two-seat Meteors were used in the target facilities role, some fitted with simple centreline quick-release fittings to allow a basic drogue target to be towed. These aircraft are described above under the 'F(TT).Mk 8' entry.

The RAF (and especially the Fleet Air Arm) had an urgent requirement for a more sophisticated target-tug, capable of streaming more complex targets or multiple successive drogues, fitted with a winch and carrying a dedicated winch operator. Such an aircraft could replace the elderly Fairey Firefly TT.Mk 4s, Short Sturgeon TT.Mk 2s, Beaufighter TT.Mk 10s and Mosquito TT.Mk 35s then in use. With twin engines, two seats, plentiful spares, good performance characteristics and low operating costs, and with large numbers of available surplus airframes, the Meteor night-fighter was a natural choice.

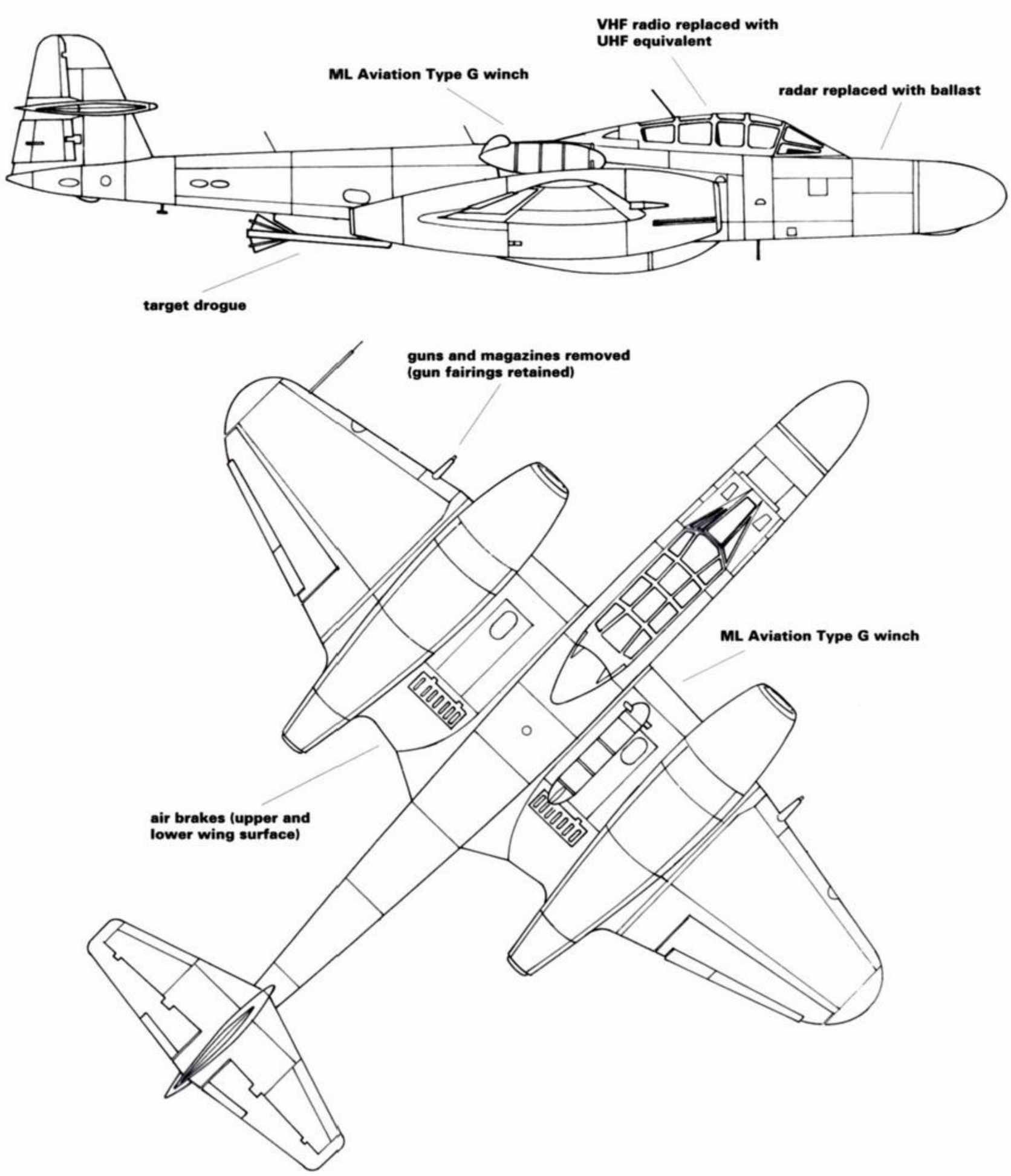
Early target-towing trials were conducted by Armstrong Whitworth and the A&AEE using NF.Mk 14s WS844 and WS751, and NF.Mk 11 WD767, which first flew in what would become TT.Mk 20 configuration in March 1957. The system fitted to the NF.Mk 11 showed greater promise, and was selected to form the basis of a new target-towing Meteor variant. The NF.Mk 14 was available in smaller numbers than the older NF.Mk 11 (indeed, when the programme began, some were still in front-line use), while its clear cockpit canopy and more modern systems made it more useful in the navigation training role. The tropicalised NF.Mk 13s were in demand for resale to Middle Eastern operators (most of the survivors were refurbished and resold to Israel, Egypt and Syria); the NF.Mk 12s were generally in poorer condition than the surplus NF.Mk 11s, while they were more attractive for spares recovery to support the remaining NF.Mk 14s. The decision was therefore taken to standardise on the NF.Mk 11.

The resulting target-towing Meteor TT.Mk 20 was thus based on a factory-refurbished NF.Mk 11 airframe, with armament and armament-related systems removed to save weight, and with UHF radio replacing the original VHF. An ML Aviation Type G wind-driven winch was fitted on a streamlined pylon above the rear part of the starboard inboard wingroot, with the 6,100-ft (1860-m) cable routed via strut-mounted pulleys to the centreline of the rear fuselage. Here it was attached (via a pyrotechnically operated cable cutter) to a target exchange and release unit, which allowed successive targets to be retrieved and deployed. The four standard targets were stowed in canisters in the rear fuselage, or alternatively, from 1968, a single Rushton target could be carried by FRU TT.Mk 20s on a drop-down launcher, with a lower profile Del-Mar winch (with more cable length) in place of the ML unit. Some TT.Mk 20s had a steel deflector wire running from the tailplane tip down to a point under the rear fuselage.

Conversions by Gloster, Armstrong Whitworth (at Baginton, Bitteswell and at the former Gloster works at Moreton Valence), and RNAY Sydenham totalled 43, comprising WD591, WD623, WD629, WD630, WD647, WD679, WD702, WM224, WM234, WM245, WM246, WM270, and WM293 at Moreton Valence (13), WD610, WD612, WD649, WD652, WD657, WD678, WD711, WD767 (prototype), WD780, WD785, WM147, WM151, WM160, WM242, WM255, WM260, WM292 at Baginton/Bitteswell (17), WD585, WD592, WD606, WD645, WD706, WM159, and WM230 at Sydenham (seven) and WD643, WD646, WM148, WM167, WM181, and WM223 whose place of conversion is unknown (six). In addition to these conversions, NF.Mk 11s WD677, WM163 and WM172 were delivered to Lossiemouth, but were in unacceptably poor condition and were returned to the RAF for scrapping. The first 'production' conversion was WM242, which first flew as a TT.Mk 20 in 1957.

The Navy's TT.Mk 20s initially served with the Lossiemouth Handling Squadron at

The Fleet Air Arm was a major operator of the TT.Mk 20 tug. WW159 is seen while on strength with No. 728 Sqn at Hal Far, Malta, where it provided target facilities for the Mediterranean Fleet, the Army and the RAF Regiment.

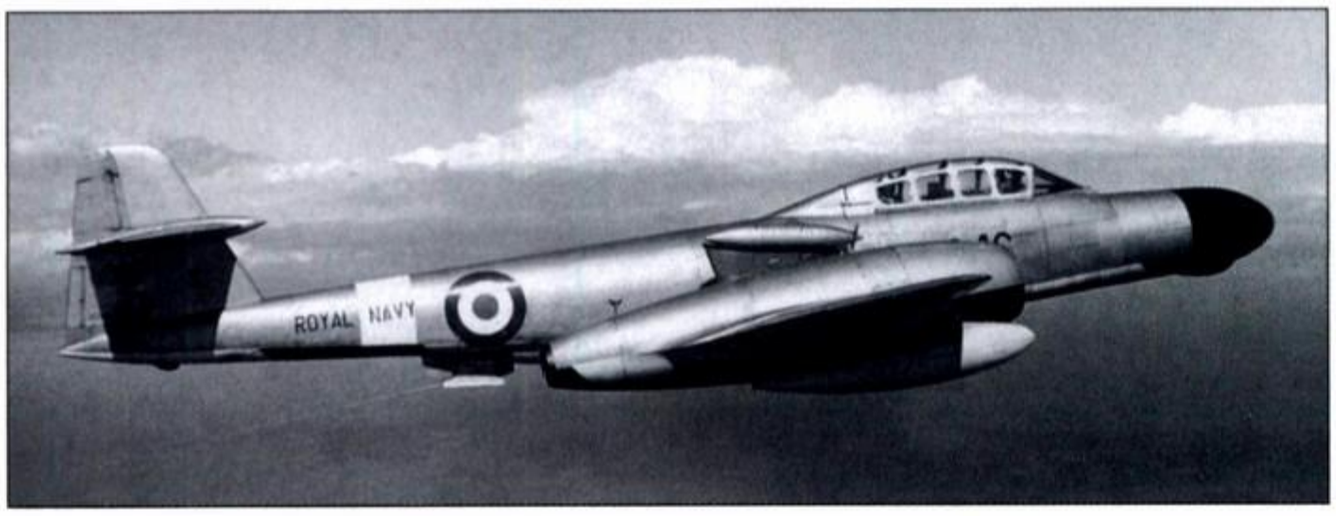

VHF radio replaced with UHF equivalent
ML Aviation Type G winch
radar replaced with ballast
target drogue
guns and magazines removed (gun fairings retained)
ML Aviation Type G winch
air brakes (upper and lower wing surface)

Meteor TT.Mk 20

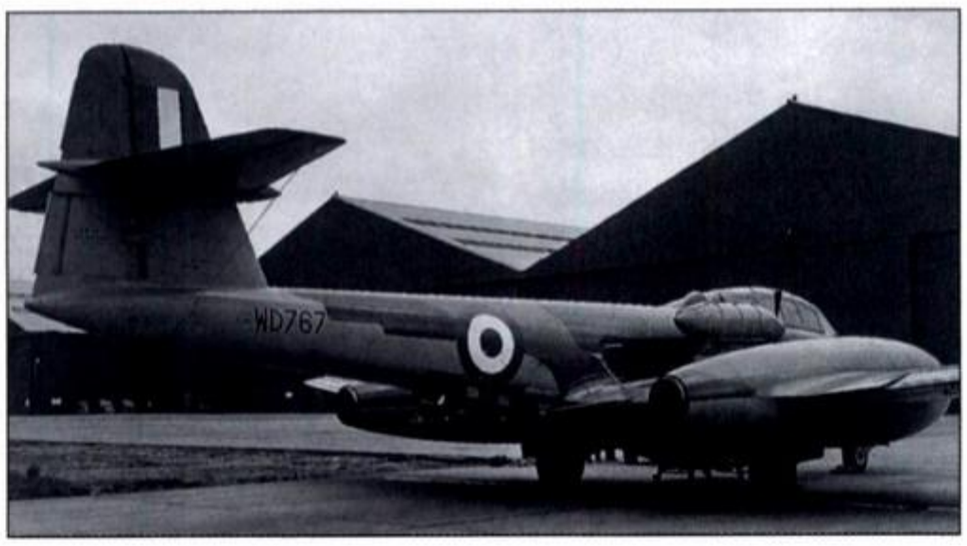
Left: WM234 is seen here with a typical Rushton target positioned ready for deployment. Just visible on the nose of the target is a microphone used in association with its Ekco 'Mis-Distance' equipment. The TT.Mk 20's yellow and black undersurface stripes were typical, though from the late 1960s, Saturn yellow undersides began to appear on FAA examples.

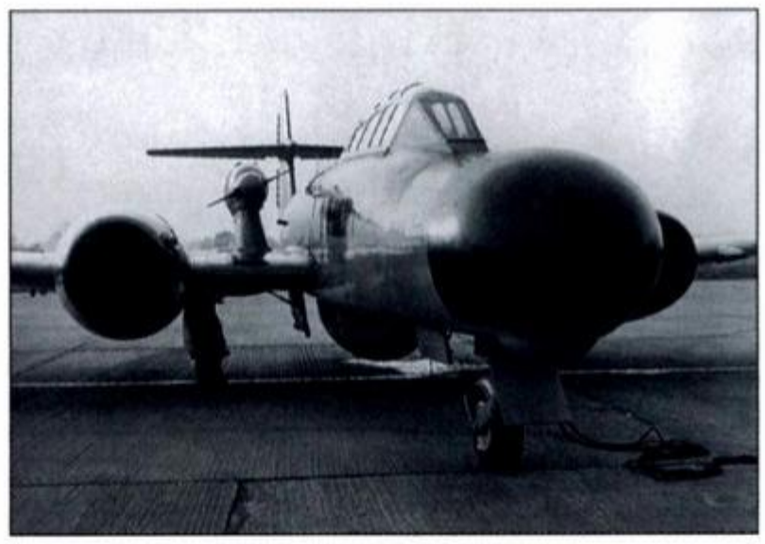
Milltown, No. 728 Squadron at Hal Far, Malta, Station Flights at Brawdy and Yeovilton, and the Fleet Requirements Unit at Hurn, which retired its last TT.Mk 20 to No. 5 MU, Kemble, on 19 February 1971. The type also saw limited RAF service, with No. 1574 Flight at RAF Changi, Singapore, No. 3 CAACU at Exeter and No. 5 CAACU at Woodvale. Two TT.Mk 20s (WM270 and WM293) served with No. 5 CAACU until 1974, following the disbandments of the other RAF units in 1970. Six TT.Mk 20s (WD649, 652, 780, WM242, 255 and 292) were sold to the CEV for spares use, and were flown from Kemble to Brétigny, all using the same F-ZABD callsign and registration. One TT.Mk 20 (WD592) was sold to a civilian owner in the USA, but subsequently crashed. WM167 served as a development aircraft with Flight Refuelling Ltd, then passed to the RAE at Llanbedr which used it until December 1975, when it was retired to a museum at Blackbushe, subsequently being restored to flying condition as G-LOSM. Another TT.Mk 20 undergoing restoration to fly is WD767, delivered from FRL to Woomera in 1970, and used there until 1975, then retired to a museum before going to its current owner in New Zealand. A sister aircraft (WD647), sent to Woomera at much the same time, also survives in a museum.

Six of the 20 Danish NF.Mk 11s (504, 508, 512, 517, 518 and 519) were converted to similar standards by Armstrong Whitworth in 1958, gaining an H prefix to their serials. Four were subsequently sold to Swedair Ltd as SE-DCF (512), SE-DCG (517), SE-DCH (508) and SE-DCI (519). After serving with Swedair between August 1962 and March 1965, the aircraft were retired. Two (-DCF and -DCH) were refurbished during 1968, and were sold to Kjeld Mortensen in Denmark in March 1969, but were quickly up for sale again. Sold to a German company (Flugzeughandelsgesell-schaft Karlsrühe), they were delivered to Germany that month. Their German registrations D-CAKU and D-CAKY were refused when it became apparent that the aircraft were en route to Biafra, and both ended up abandoned at Gosselies in Belgium until 1975, when they went to museums.



Left: This Airwork Fleet Requirements Unit aircraft is fitted with the lower profile Del-Mar winch used from 1968. Like the Type G, this was operated by a winch controller seated in the rear cockpit. Sorties, usually flown between 5,000 and 10,000 ft (1524 and 3048 m), were restricted to 90 minutes' duration by the Meteor's limited fuel capacity.





Above and above right: These rear three-quarter and front-on views of the TT.Mk 20 prototype, WD767, show the positioning of the ML Aviation Type G wind-driven winch, fixed to the upper surface of the starboard wing.

Right: Colourful Meteor TT.Mk 20 WD647 is displayed at the Queensland Air Museum, Caloundra, after some years of service at the WRE, Woomera.

Meteor U.Mk 21/21A

The U.Mk 21 designation was applied to F.Mk 8 drones converted by Flight Refuelling to meet RAAF requirements, broadly equivalent to the U.Mk 16 but with some minor differences in equipment fit. Eight U.Mk 21s were produced, and were delivered in January 1961. The original U.Mk 21s were VZ455, VZ503, WE902, WF659, WH460, WK710, WK879 and WL136. WL136 was the first to fly after conversion, on 31 May 1961. WE960 and WK797 were already in Australia as U.Mk 16s, and were modified by Fairey at Bankstown and redesignated, a total of 10.

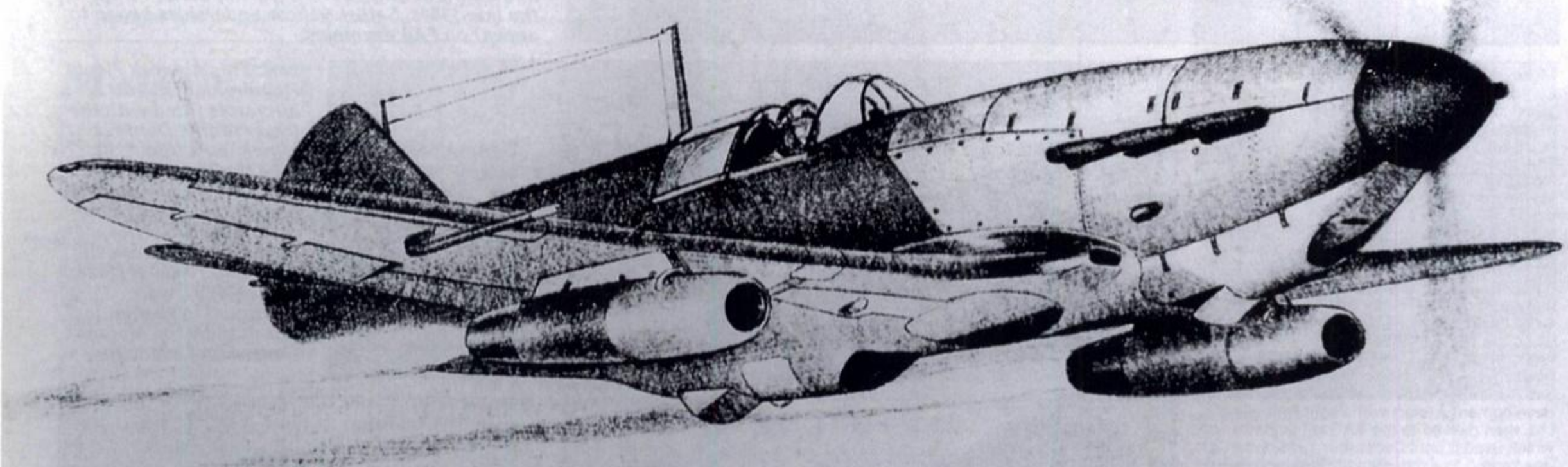
The Meteor U.Mk 21s produced by Flight Refuelling Limited were augmented by 15 ex-RAAF Meteor F.Mk 8s converted to the same standard (using kits supplied by Flight Refuelling) by Fairey Aviation at Bankstown. A77-884 made the type's maiden flight in November 1961, and the last (A77-157) was delivered in February 1963. The U.Mk 21As were A77-157, -193, -207, -422, -510, -802, -851 (George Hale's double MiG-killer), -855, -863, -872, -873, -876, -882, -884, and -885. Nine of the RAAF Meteor F.Mk 8-based U.Mk 21As were shot down (the last two surviving until November 1971), three crashed (A77-422, -855, -863), one was scrapped (-885), one was reduced to spares (-851), and in 1971 the survivor (A77-876, ex-WK800) was returned to the UK for service with RAE West Freugh and later RAE Llanbedr, where it became known as a D.Mk 16.

Right: WE960 was initially converted to U.Mk 16 standard before being shipped to Australia, where it was further modified to U.Mk 21 standard by Fairey Aviation.

Below: A77-884 was the first of the RAAF F.Mk 8s converted as U.Mk 21As, first flying as such in November 1961. It was one of nine Mk 21As destroyed by a missile over the Weapons Research Establishment's Woomera range in November 1965.

Beyond the Frontiers

Soviet mixed-power fighters 1939-46



During the 1930s, engineers worldwide turned from the limitations of piston engines to new propulsion technologies in the hope they could satisfy the air forces' ever-increasing need for more speed from their fighters. In the Soviet Union, ramjet, turbine and rocket technology were all examined, and were experimentally applied to existing piston-engined fighter designs.

Lavochkin's first ramjet-boosted fighter was a Lavochkin Gorbunov/Gudkov LaGG-3 fitted with two underwing VRD-1 ramjets, seen here in an artist's impression. First flown on 5 August 1942, its maximum speed with the ramjets firing was increased by just 12-15 km/h (7-10 mph), and on piston engine power alone their increased drag reduced performance in every respect.

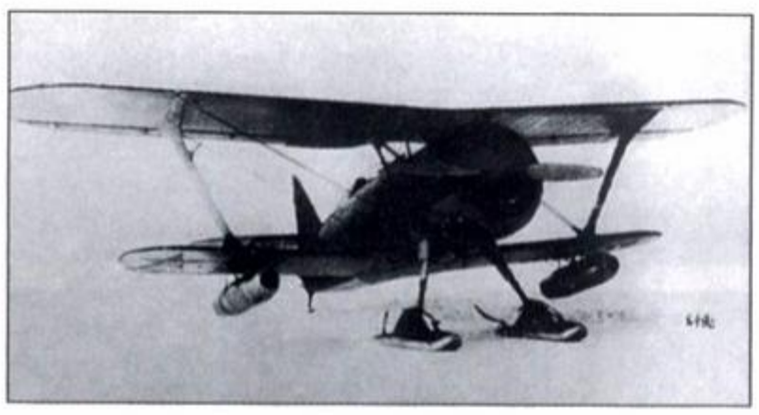
Reaction propulsion was an obvious choice, and in the USSR the main emphasis of research in the field of jet propulsion was in ramjets. They were known by the acronym PVRD, which stood for *pryamotochnii vozdushno-reaktivnii dveegatel* – literally, 'straight-through flow air jet engine'. (The reference to air was initially necessary to distinguish air-breathing engines from rocket engines, which were called ZhRD for *zhidkostno-reaktivnii dveegatel* – literally 'liquid jet engine', the 'liquid' referring to the liquid oxidiser. Later, however, the 'air' part was omitted from the terminology; e.g., TRD for *turboreaktivnii dveegatel* – turbojet etc.)

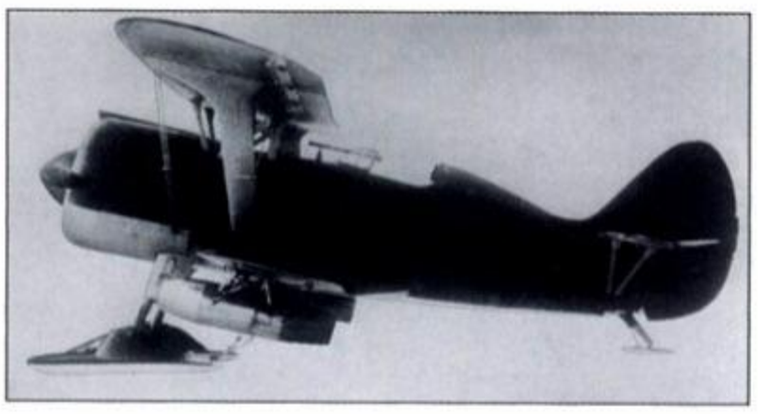
In 1931 Osoaviakhim (the Society for the Support of Aviation and the Chemical Industry, the forerunner of the post-war DOSAAF organisation) funded a group of Moscow students to study reaction propulsion engines, and the first static firing of a ramjet took place on 15 April 1933. Experiments with a 76-mm (3-in) shell modified by replacing the nose cap with an aerodynamic tube were initiated in September 1933 and continued into 1935. Lacquered white phosphorus was used as fuel. When fired from a gun, these shells were ground-breaking on two counts: they used a ramjet that developed thrust in flight for the first time, and they reached supersonic speed – something not then achieved by any rocket engine. A speed of Mach 1.7 was recorded on that memorable day. It is worth noting that further research, employing rockets as launch vehicles for ramjets which can only function by air being forced through them, paved the way for the surface-to-air missiles of the future.

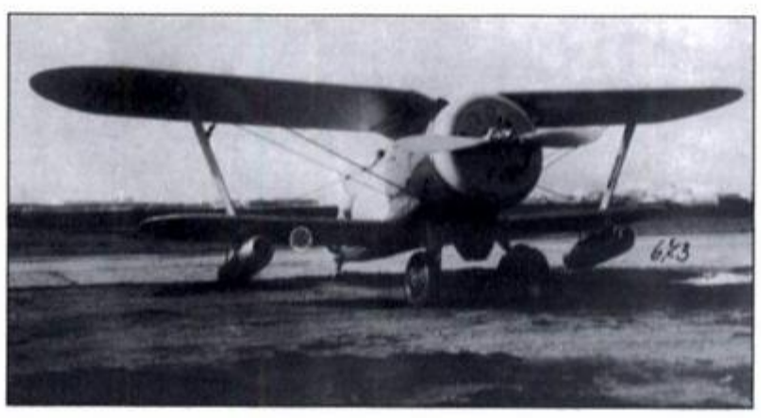
While acknowledging the necessity of continuing long-term research into jets and rockets as a single power source, the Soviets also perceived opportunities to use them as boosters on existing conventional piston-engined aircraft and, by fast-tracking their development, they could gain an immediate tactical advantage. As a bonus came the ability to implement the project without awaiting the development of new airframes.

Britain, and the USA with which it shared its research, had elected to use turbojets as a sole source of power for their fighters. Germany built both all-rocket and all-turbojet aircraft. None of these countries, with a lone exception, used rocket motors or turbojets on piston-engined fighters.

Ironically, although it was the USSR which had concerned itself primarily with mixed-power piston-engined aircraft, the USA was the only nation to mass-produce one. In late 1942, the US Navy issued a specification for a new carrierborne fighter that could not be filled by a jet aircraft. The stipulated take-off and landing performance and range could, however, be satisfied if a turbojet was installed as an addition to a piston engine, so the Ryan FR-1 Fireball was conceived. The original order of 702 was terminated at 66 by the cessation of the war.







Polikarpov I-15bis (left and below left) were test flown with 400-mm DM-2 ramjets fitted, though they made little impression on the top speed. Note the skis fitted to the undercarriage wheels of the former aircraft; on the latter machine the wheels have been completely replaced. Results were more encouraging when the same jets were fitted to the more agile I-153 (below), with its retractable landing gear, though overall improvements were limited to about 50 km/h. The OKB designations for these aircraft were I-152DM and I-153DM, respectively.

First experiments

The first Soviet experiment with mixed power took place in December 1939 when test pilot P. E. Loginov flew a Polikarpov I-15bis biplane fighter (construction number 5942) with a Merkulov DM-2 (from either *dopolneetel-nii motor*, supplementary motor or *dveegatel' Merkulova*, Merkulov engine) ramjet under each lower wing. This was the first-ever flight of a ramjet-equipped aircraft.

Developed from the earlier 240-mm (9.45-in) diameter DM-1, the DM-2 had a diameter of 400 mm (15.75 in), a length of 1.5 m (4.92 ft), a thrust of 0.19 kN (42 lb st) and ran on the same fuel as the piston engine.

The manufacturer's designation of I-152DM was given to this aircraft (I-152 was the OKB designation for the I-15bis). Maximum speed was increased by 15 km/h (9 mph). By May 1940 pilots P. E. Loginov, A. V. Davydov and N. A. Sopotsko had flown a total of 54 flights.

Better results were obtained in September 1940 when a Polikarpov I-153 (c/n 6034) was fitted with two DM-2 ramjets and further improved in October 1940 by their replacement with 500-mm (19.7-in) DM-4s. Test pilots P. E. Loginov, A. V. Davydov and A. I. Zhukov attained an increase in maximum speeds when switching on the ramjets of 30 km/h (19 mph) with the DM-2s and 51 km/h (32 mph) with the DM-4s. The aircraft was given the designation I-153DM.

The next experiments were performed in the autumn of 1940 at OKB No. 7 (*opytnoye konstruktorskoe byuro*, Experimental Design Bureau) on the third prototype of a new biplane design, BoF-1, also called I-207 (the I standing for *istrebeetel*, fighter). This was a compact lightweight interceptor designed by two young engineers, A. A. Borovkov and I. F. Florov, and powered by a Shvetsov M-63 radial engine. After initial flight tests the aircraft was fitted with two Merkulov ramjets (believed to have been DM-4s) and made about 20 flights in this configuration, but no performance figures were recorded. However, it was estimated that by using the ramjets an increase in top speed of 100-150 km/h (62-93 mph) could be achieved, and the ramjets could be used for a maximum of 20 minutes.

Borovkov and Florov's *izdeliye* D

Later, Borovkov and Florov designed a futuristic-looking fighter designated *izdeliye* D. It had very pleasing lines and was strongly reminiscent of the Saab J 21, with twin booms, a high-set tailplane, thin wings with an area of 35 m² (376 sq ft) and 18° leading-edge sweep, a 2,000-hp (1492-kW) Tumanskii M-71 radial engine (not particularly obvious from the shape of the cowling) driving a pusher propeller, and a tricycle landing gear. Unlike the J 21, however, the tailbooms incorporated Merkulov DM-12 ramjets exhausting below the twin fins, with the intakes at the front. The aircraft was 11.67 m (38 ft 3½ in) long, with a wingspan of 14.5 m (47 ft 6¾ in).

The fixed cannon and machine-gun armament was installed in the nose. The cockpit featured a pneumatic ejection system which rotated the seat downward and fired it clear of the propeller. Projected top speed on the piston engine alone was approximately 600 km/h (373 mph), rising to 837 km/h (520 mph) at 6800 m (22,309 ft) when the ramjets were brought into play. The fighter was to climb to 5000 m (16,404 ft) in five minutes. Peak fuel consumption with the ramjets working was estimated at 2160 kg (4,762 lb) per hour.

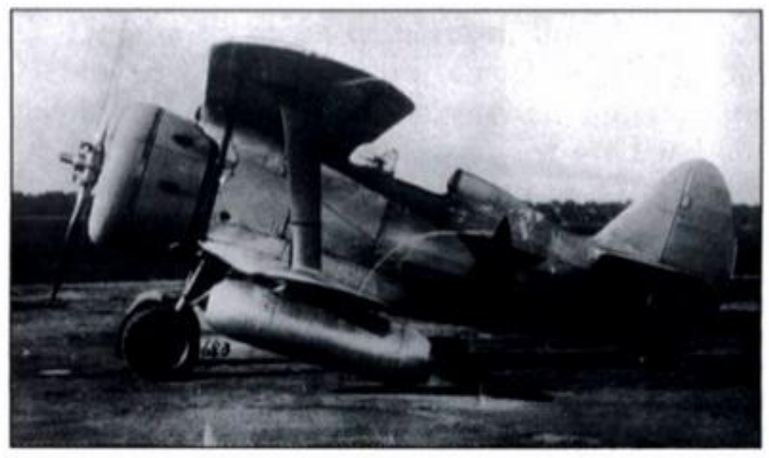
Detailed design began in 1941. Much theoretical and wind tunnel research by TsAGI (*Tsentrahlnii aero- i ghidrodinameecheskiy institut* – the Central Aero- and Hydrodynamics Institute) went into the *izdeliye* D project. Unfortunately, the Great Patriotic War interrupted the development of this aircraft at the full-scale mock-up stage.

Another project (*izdeliye* I) was developed by V. F. Bolkhovitinov. This fighter was to have two liquid-cooled piston engines mounted in tandem and driving contra-rotating tractor propellers via common reduction gear (as in Bolkhovitinov's *izdeliye* S short-range bomber), plus two integral ramjets. *Izdeliye* I also featured an ejection system. However, as with the Borovkov/Florov project, development was terminated by the war.

In 1940 V. M. Myasischchev had projected a high-speed bomber with ramjet boosters positioned inside the fuselage to avoid a reduction of top speed, rate of climb and manoeuvrability caused by the excessive drag of large nacelles. This raised the question of how ramjets would behave in such a location, and G. N. Abramovich, a section head at TsAGI, was given this problem to solve. Theoretical studies showed that the restricted airflow inside the fuselage was insufficient to produce the necessary thrust, so the project was discontinued. However, the lack of research data on reaction propulsion systems was recognised by Abramovich and he persuaded the authorities to set up a department at TsAGI for research.

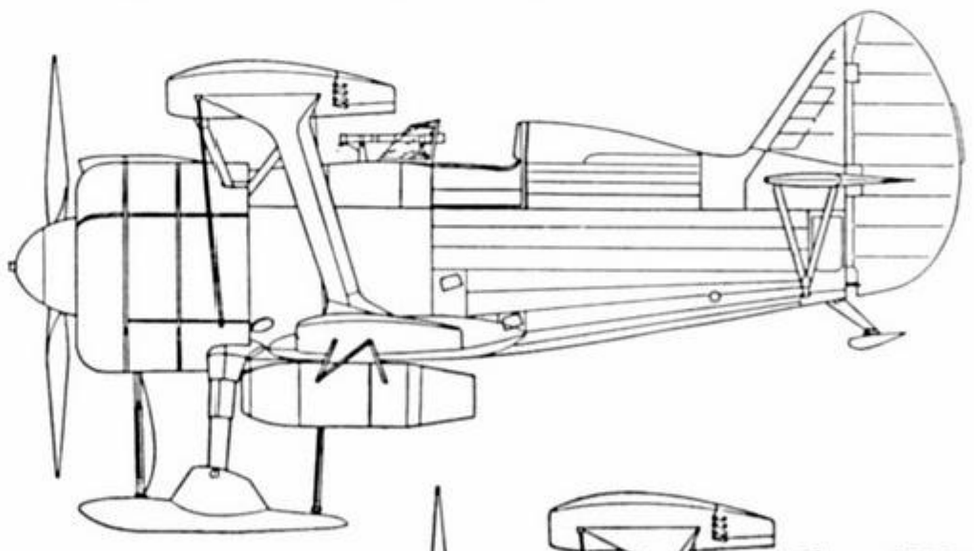
Abramovich concluded that the problem raised by Myasischchev could be solved by using a conventional piston engine to drive a compressor, thereby increasing airflow velocity. To enable him to proceed with studies of aircraft having motor compressor engines, as they were called, a TsAGI department under Abramovich was established in March 1942 to study all reaction power systems. This department included an aircraft design team and sections to focus on the working and combustion processes of these systems.

Further improvements to the I-153's top speed were possible with larger 500-mm DM-4 ramjets. Some sources record that a speed of 440 km/h was recorded on 27 October 1940, by such an aircraft flying at an altitude of 2000 m.



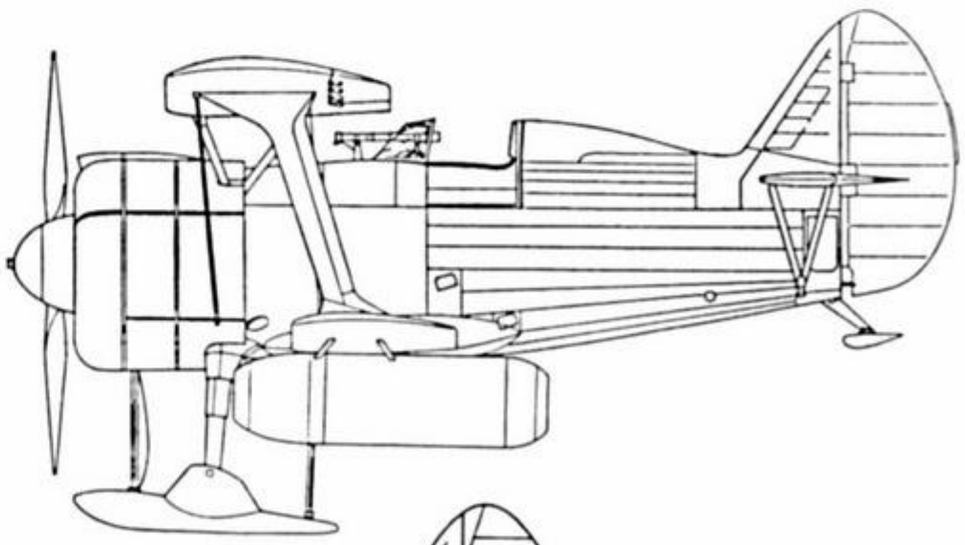
In February 1943 TsAGI formulated a project for the installation of a motor compressor engine in the rear fuselage of a

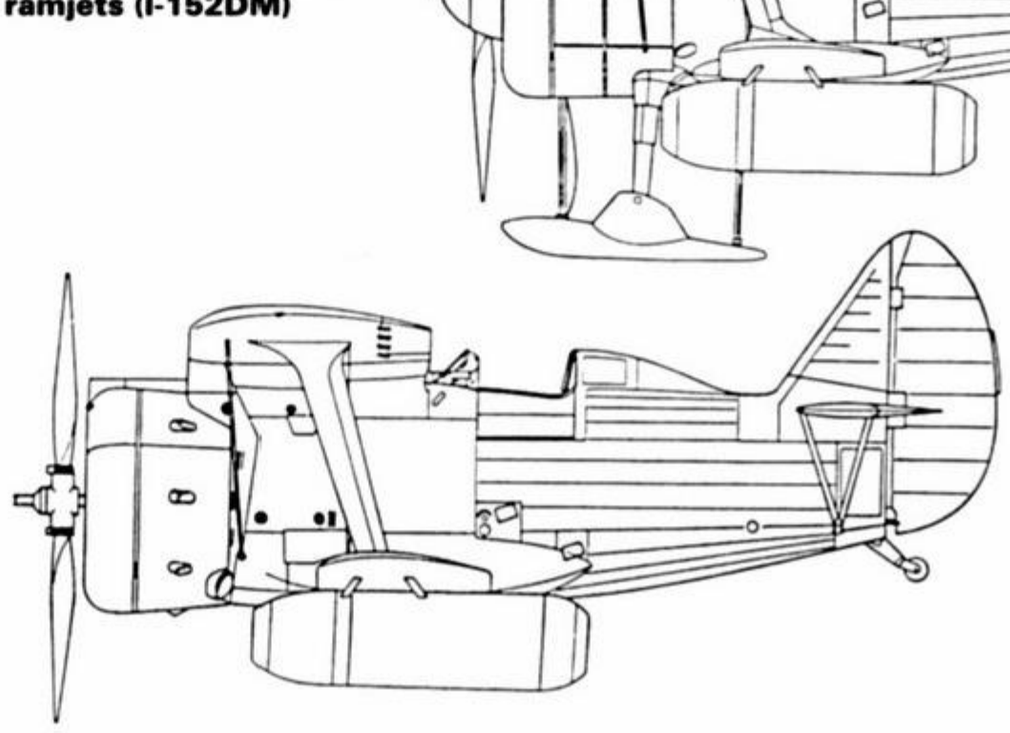
Polikarpov ram-jet fighters



(left) **I-15bis with DM-2 ramjets (I-152DM)**

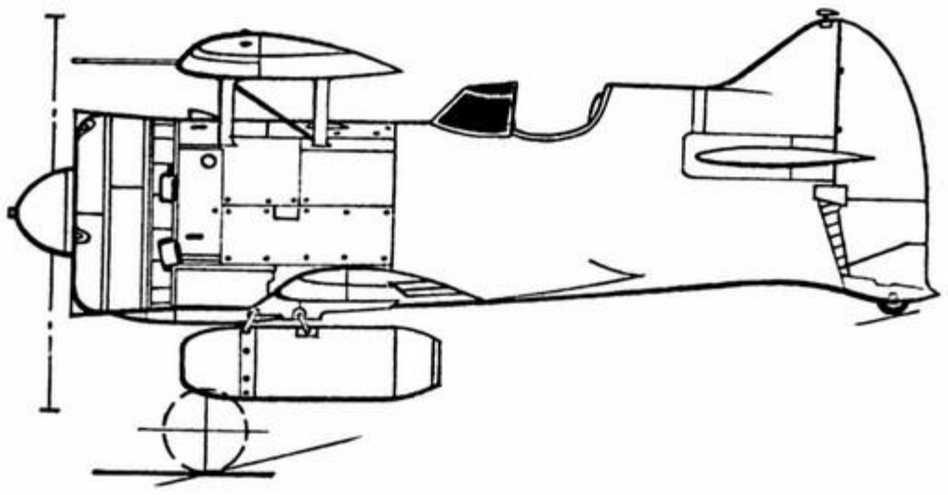
(right) **I-15bis with DM-4 ramjets (I-152DM)**



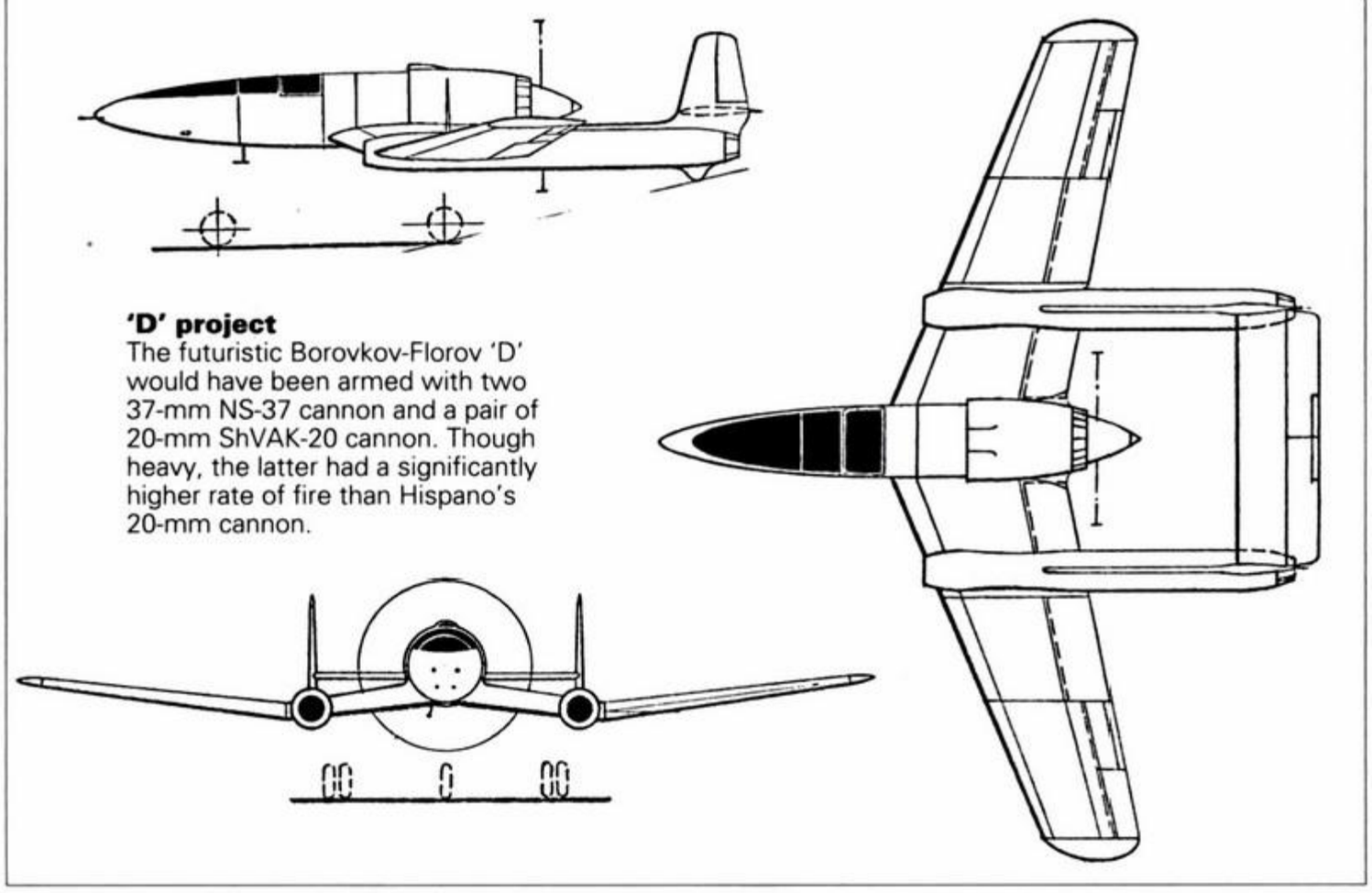


(left) **I-153 with DM-4 ramjets (I-153DM)**

Borovkov-Florov designs



I-207
The third I-207 (with retractable undercarriage, unlike the first and second examples), first flown in September or October 1939, made 20 flights with DM-4 ramjets fitted.



'D' project
The futuristic Borovkov-Florov 'D' would have been armed with two 37-mm NS-37 cannon and a pair of 20-mm ShVAK-20 cannon. Though heavy, the latter had a significantly higher rate of fire than Hispano's 20-mm cannon.

Yak-9 to be powered by a Klimov M-105REN piston engine driving the compressor and the propeller. The REN designation (*reduktornii, eksperimentahl'nii, s neposredstvennym vpryskom* – geared, experimental, fuel-injected) indicated an extra gearbox and clutch through which to drive the compressor. Unfortunately, the modification resulted in a loss of 150 hp (112 kW) compared with the standard M-105PF and the calculated speed increase was only 80 km/h (50 mph). This, together with the deletion of a ShVAK cannon and a reduction in manoeuvrability, meant that the aircraft (designated Yak-9VRDK – *vozdushno-reaktivnii dveegatel' kompressornii* for jet engine with [externally-driven] compressor, i.e. motor compressor engine) was not a viable proposition as a fighter. Indeed, it was concluded that an entirely new purpose-built airframe was needed to incorporate such a powerplant.

In March 1943 TsAGI submitted a project for an all-metal interceptor to be called S-1VDRK-1. It had no propeller but its nose-mounted Shvetsov M-82 radial engine drove a motor compressor engine. A twin tail and tricycle undercarriage were featured and a top speed of 800 km/h (497 mph) was expected. The TsAGI staff were encouraged in their efforts by an article in *Flight* magazine with details of the first flight of the Caproni-Campini CC-1, which had a similar type of propulsion arrangement.

Abramovich calculated that the optimum compression ratio for air through the compressors was 1.3-1.4 and that, with its compression ratio of 4.0, the CC-1's performance would be inferior to that of propeller-driven aircraft with a similar engine – a prediction later proved.

A twin-engined project known as S-2VDRK-2 was also studied and estimated to be 50 km/h (31 mph) faster than the S-1VDRK-1. Two other projected fighter designs were variants of the S-1VDRK-1. Both would have a liquid-cooled Vee-12 Mikulin AM-39F engine replacing the M-82 radial. The difference between them would be that the first version would have a propeller and the second would not. TsAGI estimated that if 30 per cent of the piston engine's power was used to drive the compressor, the unit would develop a similar thrust to that from the propeller, giving the two designs a top speed of 810 km/h (503 mph) and 850 km/h (528 mph), respectively.

By October 1943 TsAGI had also sketched the design for a twin-engined high-altitude reconnaissance aircraft. Two underwing 'jet' engines had turbine-driven compressors started by exhaust gases from a Charomskiy ACh-30B diesel engine located in the fuselage, the gases being fed through ducts in the leading edges of the wings. This imaginative arrangement obviated the need for transmission shafts and gear boxes.

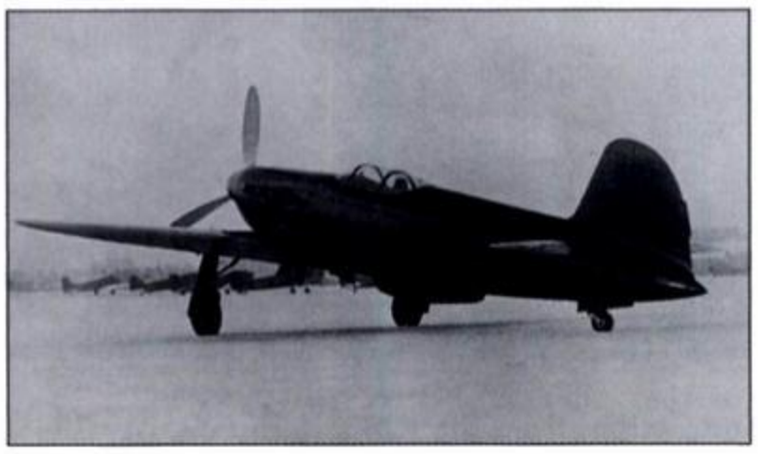
La-5 motor compressor variant

Abramovich's last project for TsAGI was a Lavochkin La-5 with a variant of the motor compressor engine, with a fan design resembling that of the BMW 801 piston engine. His decision to develop this particular fighter was a strange one, as it had already been supplanted on the production lines by the La-7.

TsAGI dropped out of the race to develop reaction propulsion engines when, in the summer of 1944, Abramovich transferred his expertise in this field to the newly-formed scientific research institute, NII-1 NKAP, where he had been appointed deputy head. A great deal of work and an even greater sum of money had been expended on the TsAGI projects described above and important conclusions drawn from the theoretical data accumulated, but none of the projected aircraft actually flew.

While TsAGI had been assessing theoretical principles, the design bureaux were adopting a more practical approach by experimenting with booster units on existing aircraft. Overcoming the disorganisation caused by factory evacuations, they were able in January 1942 to flight test Merkulov's latest ramjet, the DM-4S, which had a diameter of 500 mm (19¾ in), a length of 2.3 m (7 ft 6 in) and a weight of 45 kg (99 lb). Burning 12 kg (27 lb) of fuel per minute each, two ramjets were fitted under the wings of the UTI-26-2 (*uchebno-trenirovochnii istrebeetel* – training fighter). This was the second

A pair of Merkulov's latest DM-4S ramjets was test flown in early 1942, beneath the wings of the second UTI-26 (Yak-1 trainer) prototype.



Right and far right: Among the modifications made to the rocket-boosted Yak-3RD were the broader-chord rudder (to compensate for the lower portion lost to the rocket nozzle), Duralumin-skinned elevators and wing-mounted fuel tanks.

prototype of the two-seat trainer variant of the Yak-1 (which had the OKB designation I-26). The experiment was aborted when it was discovered that the centre of gravity was too far forward, resulting in vibrations which caused fuel leaks.

Although not strictly within the scope of this article, it is worth noting that the Yakovlev design bureau produced an interesting project known internally as the Yak-7R, the R standing for *raketnii uskoritel* (rocket booster). This should not be confused with the actual Yak-7R which was the service designation of the photo-reconnaissance version (in that case, the R denoted *[samolyot]-razvedchik* – reconnaissance aircraft). Unfortunately, the long history of the Soviet air force's insistence on using different designations from those used by the design bureaux (for security reasons) often led, as in this case, to duplication.

Rocket-boosted Yak-7

The Yak-7R project was for an interceptor with a 10.78-kN (2,425-lb st) Dushkin/Shtokolov D-1A-1100 liquid-propellant rocket engine in the tail and two DM-4 underwing ramjets. The former burned a mixture of nitric acid and kerosene, and the latter, petrol. No piston engine was to be fitted, and a maximum speed of 800 km/h (497 mph) and climb to 8000 m (2,620 ft) in under 80 seconds were anticipated. The armament was to be two 12.7-mm (0.50-in) Berezin UBS machine-guns with 200 rounds per gun. Despite its promising performance figures, the aircraft was not built; perhaps the scary thought of two undeveloped engine types in the same airframe had some influence on the decision.

Unfortunately, wartime contingencies interrupted further development of boosters at the Yakovlev OKB until 1944, when the challenge of German jet aircraft, coupled with slow development of jet engines in the USSR, brought a revival in activity. Initial trials involved slinging two DM-4S ramjets under the wings of an M-105PF-powered Yak-7B, which was redesignated Yak-7PVRD. Test pilot S. N. Anokhin made the first flight on 15 May 1944. Released performance figures indicated that only a maximum speed increase of 53 km/h (35 mph) was gained when using the ramjets – too modest an increase to merit further development. Priority was switched to rocket engines with their superior thrust-to-weight ratio; they fitted snugly into the fuselage, causing virtually no additional drag.

Before the war, Soviet engineers had been in the forefront of the race to build a satisfactory rocket fighter but their most promising product, the BI series of prototypes designed by Bereznyak and Isayev with engines by Dushkin, was abandoned in 1943. Available rocket engines were capable of only extremely short bursts of power and the Soviet air force decided that, taking into account the Luftwaffe's lack of strategic bombers, a very short-range interceptor was not a priority; therefore, no further steps were taken to rectify the BI-1's aerodynamic faults which were hindering progress. However, development of rocket engines continued and their next application was as boosters for fighter aircraft.

In late 1944 the Yakovlev OKB fitted a Yak-3 (c/n 18-20) with an RD-1 rocket engine developed by V. P. Glushko (c/n 009). The RD-1 was a pilot-controlled, single-chamber engine having a sea-level thrust rating of 2.93 kN (661 lb st). Rocket thrust theoretically increases with altitude, but the RD-1 could only reach 2.93 kN at 6500 m (21,325 ft). Fuel tanks in the wings held 50 kg (110 lb) of kerosene and 200 kg (441 lb) of concentrated nitric acid, with the fuel feed controls beneath the cockpit. Rocket engine ignition was electric and the fuel pumps were driven by the VK-105PF-2 piston engine. A redesigned tail was fitted with the thrust chamber housed in an extended all-metal tailcone and the rudder was increased in chord to compensate for the loss of its lower section.

The elevators were skinned in D1 Duralumin and given a larger cut-out at the root to prevent damage by jet blast. Petrol and oil capacity was reduced to 260 and 12 litres (57 and 2.6 Imp gal), respectively, the coolant and oil radiators were combined in the same duct and the supercharger fed from a single inlet in the port wing root. Armament consisted of a single 23-mm (0.90-in) Nudelman/Suranov NS-23 cannon with 60 rounds of ammunition.

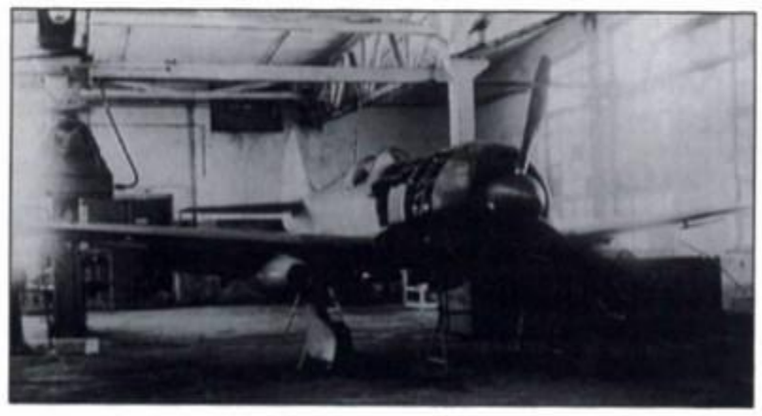
Series of misfortunes

OKB pilot V. L. Rastorguyev conducted the flight development programme between 22 December 1944 and 15 May 1945, but the electric ignition system proved unreliable and the engine was replaced by a new model, RD-1KhZ (c/n 018), with hypergolic (chemical) ignition. There followed a saga of misfortunes culminating in tragedy. To begin with, several rocket malfunctions occurred and, during a ground start on 14 May 1945, an explosion further delayed flying until 14 August 1945 to allow time for the necessary repairs and modifications to be made. On the next day, a kerosene pipe fractured. The final and most catastrophic accident occurred on 16 May: after the rocket had been shut down, the aircraft dived ever more steeply until it struck the ground at an angle of about 50°, killing Rastorguyev. The cause of the disaster was never established.

Despite its tragic truncation, the project had achieved a large measure of success. Before the accident, the Yak-3RD reached a maximum speed of 732 km/h (455 mph) at sea level and 782 km/h (486 mph) at 7800 m (25,600 ft)

Lavochkin's first experiments with rocket-boosted fighters revolved around the La-7R (right). The first example (La-7R-1), again powered by a tail-mounted RD-1 (above right), was plagued with rocket engine problems which ultimately proved fatal for its pilot. A second aircraft (with a chemically-ignited RD-1KhZ installed) was more successful and was followed by a third, more refined machine, designated La-120R (top) in July 1945.

Right and below: Sometimes referred to as the La-7VRD or La-164, the La-126VRD was an early user of Bondaryuk's VRD-430 ramjet, test flown during the revival in interest in this form of power in 1946. Improvements to the aircraft's top speed were minor.



Above: Derived from the all-metal La-9, the La-138 followed the La-126VRD. Again, test results were not encouraging and were hampered by ramjet unreliability.

Offering potentially more thrust, the D-10 pulse-jet was initially test flown under the wings of the La-7D-10 (top). Speed improvements were greater than with the VRD-430, though a speed restriction was necessary on this largely wooden aircraft. Although an La-9 derivative was built (the La-9D-13 or La-9RD, above), powered by an improved D-13 pulse-jet, it was concluded that the disadvantages of this form of propulsion (especially impaired manoeuvrability and high fuel consumption) outweighed the negligible performance benefits.

with the rocket motor firing, compared to 626 km/h (389 mph) and 600 km/h (373 mph), respectively, on the piston engine alone. Thus, with the rocket motor firing, a 182-km/h (113-mph) increase in top speed at 7800 m was recorded. In spite of this significant achievement, Yakovlev cancelled all further trials with boosters, citing the unreliability of the rocket engine as the reason. However, his decision may also have been prompted by instructions from the Kremlin in February 1945 to use the newly-developed RD-10 turbojet.

The Lavochkin design bureau was also involved in booster trials, the first experiment taking place in 1942 on a Lavochkin Gorbunov/Gudkov LaGG-3 (c/n 31213173) which was fitted with two underwing VRD-1 ramjets designed by M. M. Bondaryuk. These supplementary engines had a diameter of 140 mm (5½ in) and a length of 2.15 m (7 ft 1½ in); these parameters later changed to 170 mm (6¾ in) and 1.9 m (6 ft 3 in), respectively. Both versions weighed 16 kg (35 lb) and fuel was supplied through a BNK-10 pump fitted to the right-hand drive of the engine's synchroniser, with air from the engine's compressor assisting the flow of the petrol, and partly vaporising it. Test pilot Mischchenko made the first flight on 5 August 1942 and completed 14 flights by the time the trials programme ended on 14 August. Maximum speed with the ramjets firing was increased by 12-15 km/h (7-10 mph) but when the ramjets were not firing their increased drag reduced all performance parameters, including maximum speed which fell by 35-40 km/h (22-25 mph). Several recommendations were made, including ameliorating the aerodynamics of the ramjet nacelles, finding a more efficient fuel pump, improving the combustion process and ensuring that the ramjets would light up reliably at high altitude.

Further work with ramjets was suspended pending further development; in the meantime, the OKB diverted its energies towards the exploitation of rocket boosters. In 1944 Lavochkin fitted an La-7 with rocket boosters at factory No. 51 at Moscow-Khodinka. As with the Yak-3RD, a Glushko RD-1 liquid-fuel rocket engine was fitted in a tailcone located below a cut-down rudder which was increased in height to make up for the area lost. The aircraft received the OKB designation La-7R (*raketnii*) and the prototype (incidentally, converted from the first production La-7) was known as the La-7R-1. Kerosene was carried in the starboard wing and nitric acid in the central fuel tank, both under a pressure of 40-50 atmospheres. They were fed by a pump driven by the main engine into a combustion chamber maintained at a pressure of up to 23 atmospheres. Fuel necessary for a little over 3.5 minutes' rocket activity was carried but this reduced petrol capacity by 38 per cent. Great care was taken to prevent acid corrosion by insulating appropriate parts. Pilot control of the rocket motor was simplified to the use of only the air valve starter and throttle handle.

Ground running trials of the rocket motor started in October 1944 with the first flight taking place in early November. A. V. Davydov completed testing on 24 February 1945, by which time an increase in top speed of 85 km/h (53 mph) had been recorded and the rocket engine fired on five of the 15 flights. Ignition failures and untenable vibrations after the rocket motor was switched off were found to be insurmountable problems.

A second La-7R with improved aerodynamics was assembled from parts intended for aircraft of the 51st production batch and became the La-7R-2. Between 26 January and 27 March 1945, 19 test flights were made with a maximum gain of 95 km/h (59 mph) at 2600 m (8,530 ft) when the rocket motor was fired. Engine reliability was unimproved; it failed to start 15 times during 45 ground and air tests. Six of these failures were caused by the electrical ignition and chemical ignition was substituted.

Chemical ignition hazards

An RD-1KhZ engine with chemical ignition was installed in the La-7R-1 on 29 April but proved no more reliable and, on 12 May, the combustion chamber exploded during ground tests. Chemically-ignited engines had also been installed in a Petlyakov Pe-2 dive bomber and a Yak-3RD, but within a few days of the La-7R-1's disaster they, too, exploded – this time in flight, with fatal results. Laboratory tests indicated that the ignition fuel spray was fractured by surge shocks in the combustion chamber occasioned by an abrupt increase in pressure in its cooling jacket when the fuel valve opened. Remedial measures included the fitting of special starter and bleed valves to ensure sequential opening of the fuel injector nozzles.

The modified RD-1KhZ was fitted on 25 July to the La-7R-2 to replace its previous engine, which also had exploded during ground tests. Flight tests were carried out between 25 July and 16 September, during which time two pumps and four combustion chambers had to be replaced. Eight start-ups were successfully made in flight, in addition to 41 on the ground, but still the RD-1KhZ failed to fire 23 times. The highest recorded top speed was 795 km/h (495 mph).

On 2 July 1945 the third rocket-powered Lavochkin fighter, designated La-120R, took to the air. It was the prototype La-7 (OKB designation La-120) modified to take an RD-1KhZ engine. The installation was similar to that of the La-7R-2, with a rebuilt rear fuselage and tail unit but with the main engine moved 7 cm (2.75 in) forward and one of the two NS-23 cannon replaced by a B-20 cannon. As the La-120R was aerodynamically more refined than previous aircraft, expectations were high. Unfortunately, overheating of the piston engine's oil necessitated a system redesign after the first two flights and flying did not recommence until mid-1946, when the combustion chamber had to be replaced after the first flight. Three more combustion chambers failed before a stainless steel chamber was installed. It worked, but by then the piston

engine needed replacement and the airframe had become so badly corroded that, in October 1946, after 16 test flights had been made, S. A. Lavochkin personally called a halt to the programme.

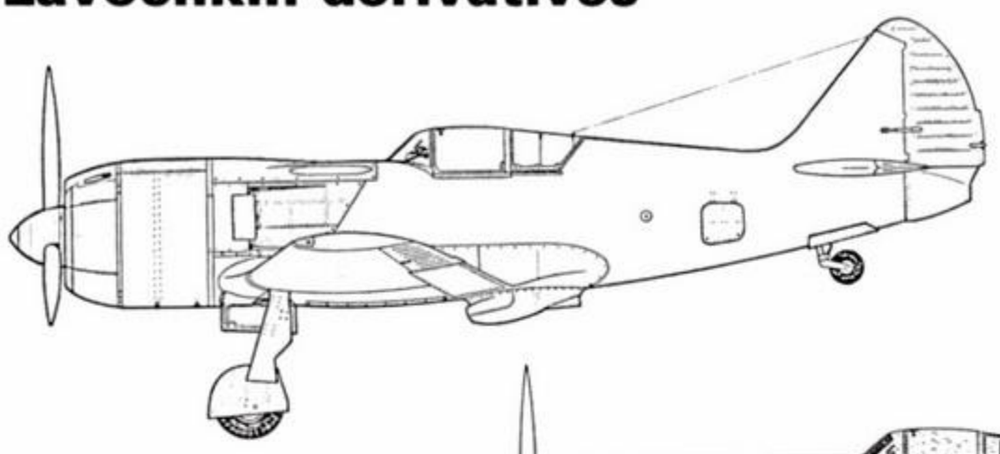
Assessment of the La-120R's maximum speed with the rocket motor running had only been possible on one occasion when 725 km/h (451 mph) was recorded, an increase of 103 km/h (64 mph) over its unboosted speed.

The La-120R's one moment of glory was in August 1946 when, with its rocket motor firing, it joined the Air Force Day flypast.

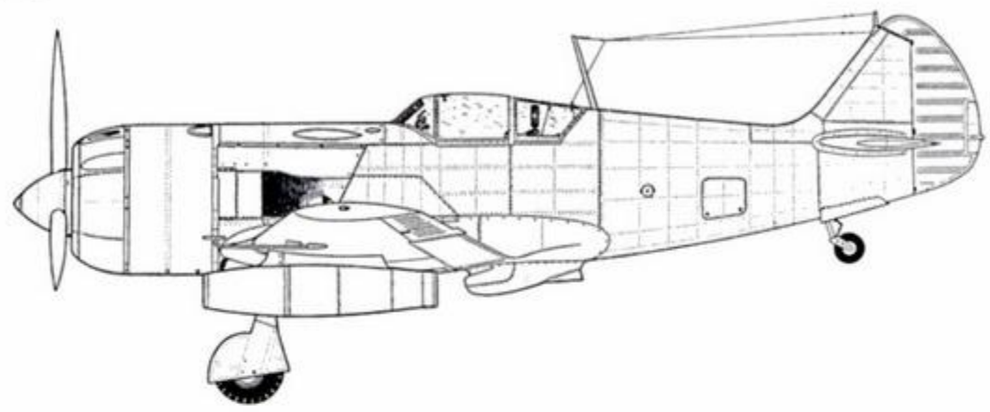
In the spring of 1946 an all-metal aircraft was earmarked for trials with a Glushko liquid-fuel rocket. In a burst of misplaced optimism, it was anticipated that significant numbers of the new Lavochkin La-9 (OKB designation La-130), which was about to enter production, would be fitted with RD-1KhZ rocket engines. Although trials were planned for two aircraft designated La-130R, there is no evidence that more than one airframe was modified at factory No. 301 in Khimki, a suburb of Moscow. In this aircraft a new Shvetsov ASh-83FN radial engine was installed farther forward than the standard ASh-82FN to compensate for the extra weight aft of the C of G. Kerosene and nitric acid tanks were built into the aircraft, two cannon omitted, the vertical tail enlarged and the rudder and elevators given metal skins. All this proved fruitless, as problems with the rocket engine on the La-120R could not be solved quickly and, although the airframe had been completed, all trials with the Glushko liquid-fuel rocket booster were cancelled.

It was intended in early 1945 to use the La-7 as a testbed for a new rocket booster, the RD-2M-3V designed by Dushkin. Commencement and completion dates for the trials were already set but the programme was cancelled when the engine failed to reach a satisfactory stage of development in time. In the event, this was a wise decision, as the final tests were not completed until 1948.

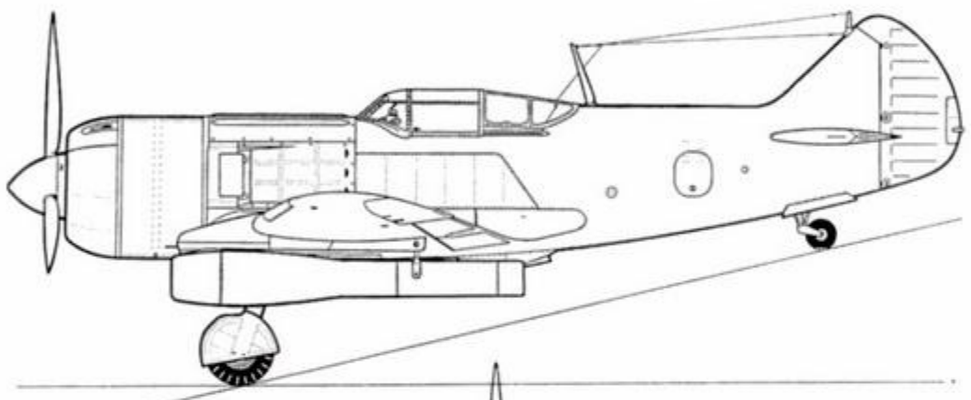
Lavochkin derivatives



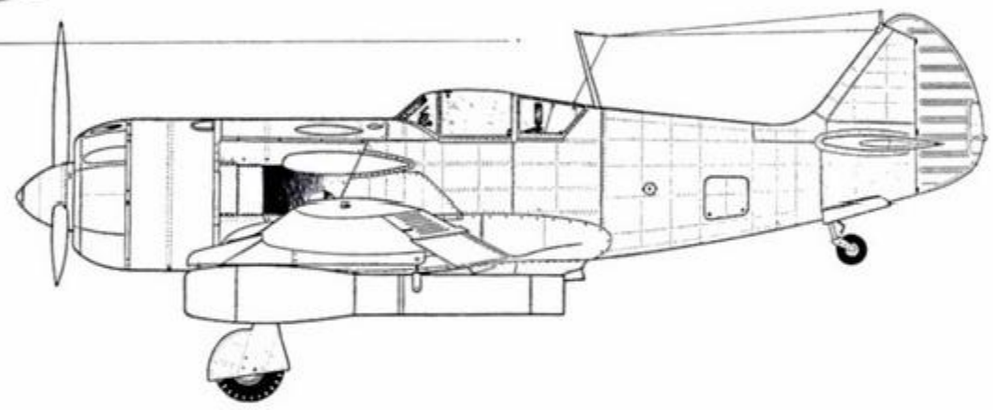
(left) **La-120R**



(right) **La-138 (Type '138')**



(left) **La-7D-10**



(right) **La-9RD (La-9D-13)**

Further ramjet experiments

When Bondaryuk's VRD-430 engine became available in 1946, the Lavochkin OKB took up where it had left off in 1942 and resumed work on ramjets. Engineers at factory No. 301 first considered fitting two of Bondaryuk's new ramjets (thrust 1.66 kN/374 lb st at sea level, diameter 43 cm/17 in) to the experimental La-120 which had already been accepted for service with the Air Force as the La-7. On further reflection, they decided instead to fit the ramjets to the more advanced La-126 which had the advantages of a heavier armament (four NS-23 cannon) and other refinements. The factory project number for this mixed-power aircraft was 164 (La-164) but the aircraft was also referred to as La-126VRD or La-7VRD. The 164 was modified for ramjet installation by removing two cannon, strengthening fin and rudder spars, adding four easily removable attachments for the engine nacelles to each wing, and fitting the appropriate fuel feed and control systems.

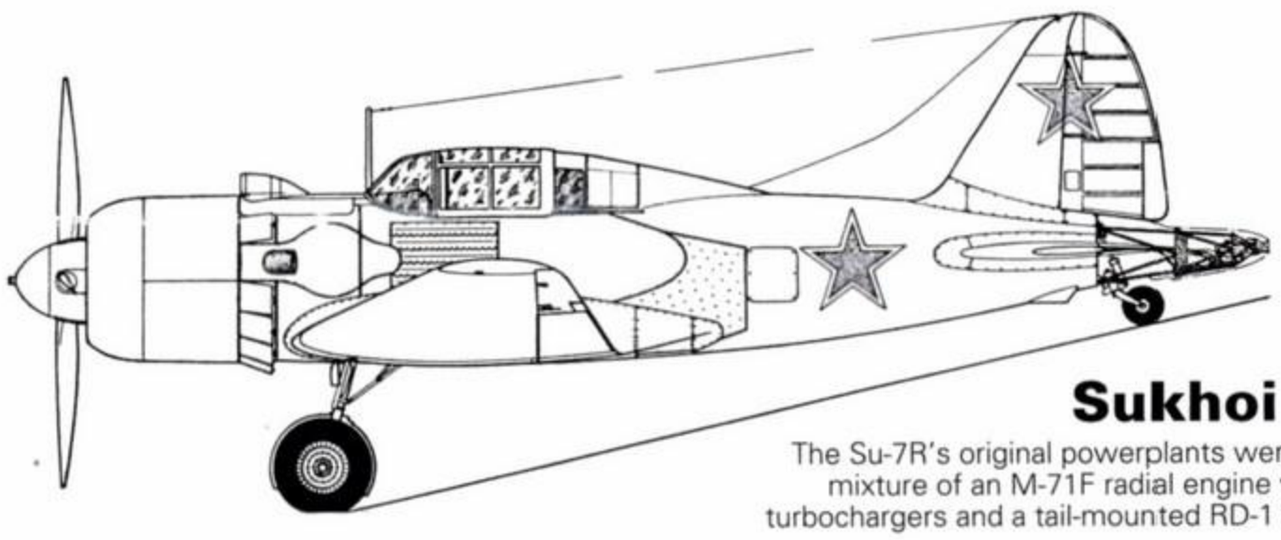
From 26 June to 4 September 1946 test pilots A. V. Davydov and A. A. Popov logged a total of 12.5 hours in 34 flights; the ramjets operated in 30 flights, running for a total of 46 minutes. The pilots reported that handling was not impaired but the take-off run was more than 100 m (320 ft) longer. Analysis of performance at 2340 m (7,700 ft) showed that the boosted speed of the 164 was as high as 694 km/h (431 mph) compared to 585 km/h (363 mph) unboosted, amounting to an increase of 109 km/h (68 mph). However, this result did not seem so impressive when it was realised that it represented an increase of only 64 km/h (40 mph) over the aircraft's performance before the addition of ramjets.

Development of the VRD-430 and its control systems continued and during 1947 two Lavochkin La-9s were fitted with a pair of underwing VRD-430s. The all-metal La-9 was a much-improved development of the La-7 but the outer starboard cannon was removed to make room for the drive and control equipment of the ramjets. The two aircraft were referred to as La-138 and La-138D, the D standing for *dublyor* (second prototype, in the Soviet terminology of the time). Flight testing started in February 1947, the first aircraft making 20 flights and the second prototype 38. Top speed improvement with the ramjets working was about 60 km/h (37 mph) compared with a standard La-9. The ramjets proved to be unreliable and gave problems on 19 occasions. More puzzling was their unreliability above 3000 m (9,840 ft). The trials were ostensibly suspended, until the ramjets could be made to perform more effectively at all altitudes and speeds, but were, in fact, terminated.

In the meantime, V. N. Chelomey at factory No. 51 was developing pulse-jets (PuVRD, *pulseerouyoushchiy vozdushno-reaktivnii dveegatel*). Pulse-jets are a form of ramjet with spring-loaded flap valves which open as air passes through them into a combustion chamber into which fuel is sprayed and ignited by a spark plug. As chamber pressure increases, the flap valves close and exhaust gases are forced out through the nozzle at the rear, giving a thrust that propels the vehicle forward. As the gases surge out, the pressure inside falls, the forward motion pushes air through the flaps and the cycle is repeated.

In November 1945 two model D-10 pulse-jets (D for *dveegatel*; sometimes referred to as RD-10) were fitted under the wings of an La-7, subsequently known as La-7D-10. These engines each developed a thrust of 2.00 kN (450 lb st), using the same fuel as the ASh-82FN piston engine. The first flight took place the following year at factory No. 51 (Moscow-Khodinka airfield) with N. V. Gavrilov at the controls, and by the summer, flight tests had been satisfactorily passed. With the pulse-jets working, top speed increased by 119 km/h (74 mph) at 3000 m (9,840 ft); this was 29 km/h (18 mph) better than estimated. However, speed was restricted to 630 km/h

Right: Developed from the Su-6(A) shturmovik, *the Su-7 high-altitude fighter was originally powered by a turbocharged M-71F radial engine. This was later exchanged for a non-turbocharged and derated ASh-82FN, with an RD-1KhZ rocket engine installed in its tail to make up the power shortfall. Notable in this view of the Su-7R are the metal plates fitted to the wooden forward fuselage aft of the piston engine's exhaust, to protect it from turbocharger 'torching' when it was powered by the M-71F.*



Sukhoi Su-7R

The Su-7R's original powerplants were an elaborate mixture of an M-71F radial engine with twin TK-3 turbochargers and a tail-mounted RD-1 rocket engine.

Though Glushko's RD-1KhZ rocket motor fitted to the Su-7R (above) produced 2.94 kN of thrust, this was insufficient to increase top speed by a useful margin and, what is more, the RD-1 suffered continued reliability problems.

(393 mph) for safety reasons imposed by the wooden airframe – a wise restriction, as it transpired, because in October 1946 at the annual maintenance check the airframe was deemed unsafe for further flights.

A recommendation was made for tests to continue on all-metal airframes only, but this did not stop Minister of Aircraft Industry M. V. Khrunichev from ordering three La-7UTI two-seaters of mainly wooden construction to be fitted with D-10 ramjets for the 1948 May Day flypast. In the event, the aircraft, although ready, did not take part in the flypast. No information has been made available on the performance or fate of these aircraft.

Chelomey developed an improved pulse-jet, the D-13 (or RD-13), with more efficient diffusers and rocker-valve boxes. Fuel was fed into the combustion chamber at a higher pressure. Two of these D-13s were fitted under the wings of an La-9, an all-metal development of the La-7, which then became known as the La-9D-13. Additional modifications were made: the seat armour and two wing cannon were removed, the wing ribs on which the pulse-jets were mounted and the tailplane tips were strengthened, the elevator trim tabs were modified and the engine cowling was fitted with a new stronger and doubly secured rear ring band. Finally, 60 kg (132 lb) of ballast was attached to the reduction gearbox casing to move the C of G forward.

Another 12 La-9D-13s were built, all of which took part in the low-level Air Force Day flypast at Moscow-Tushino airfield on 30 August 1947. Undoubtedly, the intention was to give the impression that this type was in series production.

Tests had begun earlier in August to determine the performance parameters of the La-9D-13. Top speed was increased by 127 km/h (79 mph) with the pulse-jets running, only 70 km/h (44 mph) faster than a standard La-9. Furthermore, the extra drag of the pulse-jets when not operating reduced the top speed by 57 km/h (35 mph) in comparison with the La-9.

The increase achieved over the top speed of the La-9 when the pulse-jets were operating was only marginally greater than with ramjets, both types of boosters additionally sacrificing too much in the way of manoeuvrability and rate of climb. Most important of all, excessive noise and vibration from the pulse-jets caused pilot fatigue and, together with a voracious appetite for fuel, these deficiencies sounded the death knell for the use of pulse-jets as boosters.

Sukhoi joins mixed-power 'club'

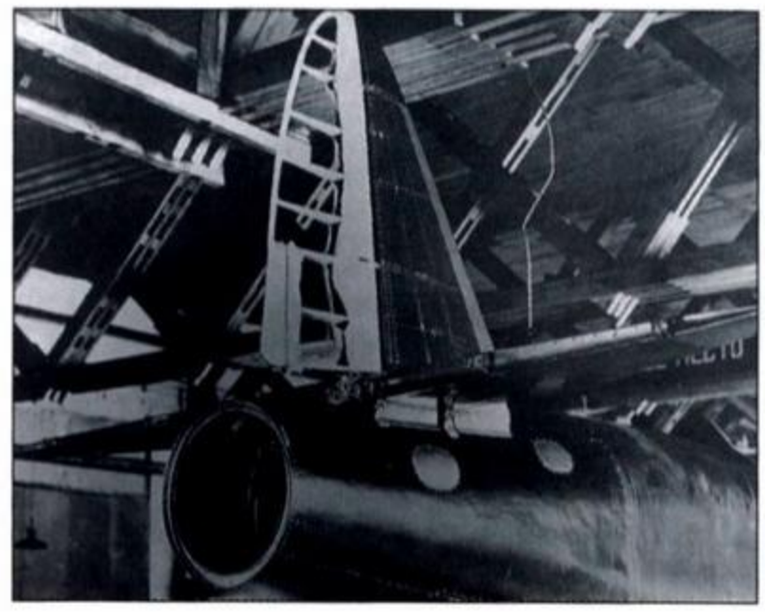
The Sukhoi design bureau's first venture into mixed-power fighters was a 1942 project exploring the feasibility of using a fuselage-mounted piston engine which would drive twin fans to compress the air for a jet engine situated aft. An all-metal, low-wing design with conventional empennage was chosen. No designation is known for this project, which in all probability was abandoned at an early stage for want of a practical jet engine.

Early in 1943 a project was initiated for another single-seat fighter. Its propeller was to be driven by an M-30V piston engine whose exhaust would feed into two wing-mounted jet engines in the vain hope of augmenting compression. A maximum speed of 770 km/h (478 mph) was envisaged. Again, no designation is known and the aircraft was not built.

The Sukhoi OKB, like those of Lavochkin and Yakovlev, also experimented with rocket engines as boosters. Disappointed at the denial of production status to his *shturmovik* (attack aircraft) design, the Su-6, Sukhoi adapted it as a high-altitude single-seat fighter. Designated Su-7 by the OKB (the first aircraft to bear this designation), it had an M-71F liquid-cooled engine rated at 2,200 hp (1641 kW) with two TK-3 turbosuperchargers (TK = *turbokompressor* – supercharger). The fuselage had a wooden frame covered with a stiffened plywood skin. The wing centre-section was metal and the outer panels wooden with metal spars. The wings had control surfaces with metal frames and fabric covering, automatic leading-edge slats and a trim tab on the port aileron. The horizontal tail was metal and had trim tabs on the elevators but the vertical tail was wooden. The armament comprised a 20-mm (0.78-in) Shpitalnii/Vladimirov ShVAK gun in each wing. Top speed was estimated to be 635 km/h (395 mph) at high altitude.

The Su-7's first flight took place in 1943. On completion of the manufacturer's trials it was found that the engine needed replacement, but, in the interim, a decision had been taken not to put this type of engine into production. The second choice was a specially-modified 1,800-hp (1342-kW) ASh-82FN with no turbosuperchargers, but the predicted maximum speed of 500 km/h (311 mph) at altitude was considered too slow. The remedy was found by installing a Glushko RD-1 delivering 2.94 kN (661 lb) of thrust in an extended tailcone. This rocket motor, as noted earlier, burned a mixture of nitric acid and kerosene (of which enough was carried for a burn of about four minutes) and was estimated to increase the top speed of the Su-7 from 590 km/h (367 mph) to 680 km/h (423 mph) at 7500 m (24,600 ft). To protect the wooden fuselage, an extended metal plate was fitted. Both engines were installed in 1944.

Flight trials were conducted by test pilot G. Komarov and a top speed of 597 km/h (371 mph) with booster operating was recorded at 6300 m (20,660 ft). The rocket motor was assessed to have contributed at the most an extra 91 km/h (57 mph). A total of 84 start-ups, both on the ground and in the air, were attempted, in the course of which four RD-1 rocket motors were destroyed by explosions. At this stage an engine with chemical ignition, the RD-1KhZ, was installed and a further 18 ground start-ups made. Unfortunately, the booster engines were very unreliable and after many failures it was decided in late 1945 to discontinue development. Flight tests had lasted



By the time the Su-5 (above left) had flown, mixed-power had been all but abandoned, pure jet aircraft having already flown. In the above view the tailpipe housing for the VRDK air-reaction engine compressor may be seen. The aircraft's rudder awaits its fabric covering.

from 31 January to 19 December 1945.

By January 1944 the USSR had got news of the existence of successful British and US jet aircraft and of rocket-powered and jet aircraft about to come into service with the Luftwaffe. Two weeks later Lavochkin, Mikoyan, Sukhoi and Yakovlev were instructed by the GKO (*gosudahrstvennii komitet oborony*, the State Committee for Defence, an emergency organisation that governed the USSR during the Great Patriotic War) to design and build jet aircraft as a matter of the utmost urgency. Stalin blamed the design bureaux for the fact that this had not already been accomplished.

A. M. Lyul'ka had reached the stage of testing his VRD-2 turbojet, but after their experience with underdeveloped rocket motors and ramjets the OKBs looked for a more mature product. The Sukhoi and MiG design bureaux eventually selected the VRDK (*vozdushno-reaktivnii dveegatel, kompressornii*). This was the motor compression engine favoured by Abramovich that K. Kholschchevnikov started to develop in 1942 at TsIAM (*tsentrahlnii institut aviatseeonnovo motorostroyeniya* – the Central Institute of Aero Engines) in Moscow. Aviation fuel was used and the VRDK's compressor was driven by a traditional piston engine by means of an extension shaft. The jet had a maximum operating time of 10 minutes and could be used as a booster on a propeller-driven aircraft.

The main engine selected was a 1,650-hp (1230-kW) Klimov VK-107R (M-107R; R = *reduktornii* – geared) driving a four-bladed propeller as well as the compressor of the VRDK. Air was supplied through a duct below the propeller spinner and continued its passage along the bottom of the fuselage through the compressor and a radiator into a combustion chamber with seven fuel injectors, each with its own spark plug. The chamber and injectors, both made of heat-resistant steel, were cooled by air passing through an outer jacket. After combustion, the air was discharged through a convergent-divergent nozzle.

Two fighter projects were studied by Sukhoi which differed in the position of the oil cooler, radiator details and type of jetpipe. The chosen design received the designation I-107, later changed to Su-5. This all-metal, low-wing monoplane had a blunt nose and a deep, truncated sausage-shaped fuselage giving a distinctive, if not distinguished, appearance. The armament was intended to be a 23-mm Nudelman N-23 cannon with 100 rounds and two 12.7-mm Berezin UBS machine-guns with 200 rounds per gun in the nose.

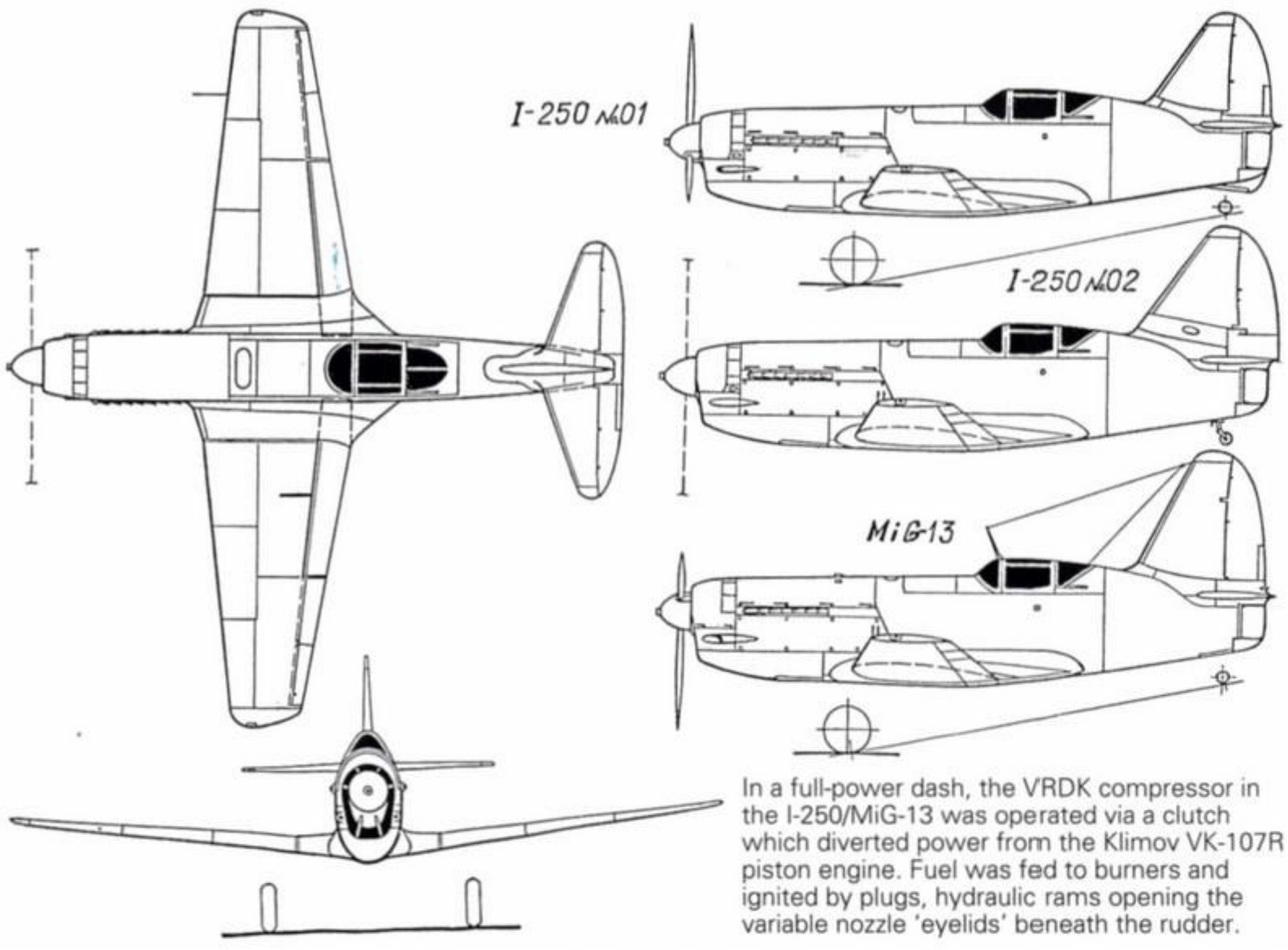
Su-5 prototypes

Two prototypes were built, of which the second was used only for wind tunnel tests at TsAGI to perfect the wing design. The first stage of the development flight tests took place from April to July 1945, during which time Sukhoi designers tried to improve the fighter's aerodynamics and finalise the wing planform.

Sukhoi Su-5 (No. 2) cutaway

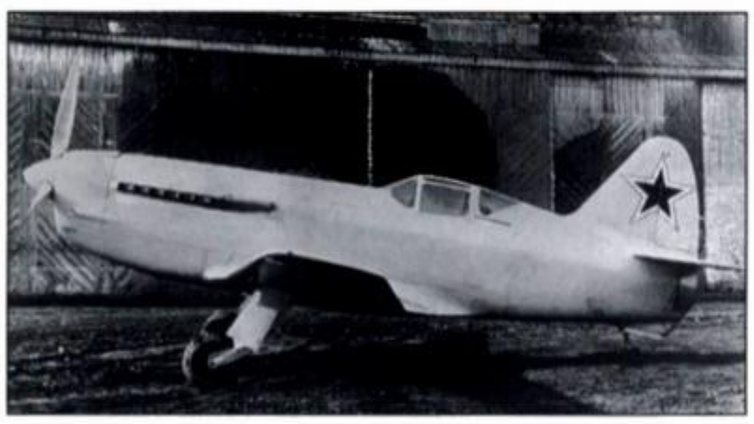
1 Cannon port
2 Spinner
3 Four-bladed controllable-pitch propeller
4 Machine-gun port
5 Header tank
6 Compressor intake
7 Compressor intake trunking
8 Reduction gear housing
9 Klimov VK-107A 12-cylinder liquid-cooled engine
10 Exhaust stubs
11 Two 12.7-mm UBS machine-guns
12 Machine-gun magazine (200 rpg)
13 Ammunition feed
14 Pitot head
15 Single-spar wing structure
16 Curved armourglass panel
17 Reflector sight
18 N-23 (23-mm) cannon breech
19 Rudder pedal assembly
20 Engine air
21 Compressor drive shaft
22 Compressor
23 Pilot's seat
24 Control column
25 Radio panel
26 Bullet-proof aft-sliding cockpit canopy
27 Aft fixed glazing
28 Fuselage fuel tank (second tank in starboard wing inner section)
29 Back armour (10-mm)
30 Circular water radiator
31 Access
32 Fuselage frame
33 Aerial attachment
34 Aerials
35 Dural monocoque fuselage construction
36 Fuel nozzle (seven) chamber
37 Double-wall/cooling air
38 Tailfin root fairing
39 Tailfin structure
40 Rudder upper hinge
41 Rudder construction
42 Rudder trim tab
43 Rear navigation light
44 Variable exhaust orifice
45 Port elevator
46 Port tailplane
47 Combustion chamber cooling air
48 Heat-resistant steel
49 Retractable tailwheel
50 Tailwheel fairing
51 Dural fuselage skinning
52 Wingroot fairing
53 Flap profile
54 Oil cooler outlet flaps
55 Oil cooler (oil tank inboard)
56 Wing spar
57 Mainwheel retraction jack
58 Oil cooler duct
59 Mainwheel inboard fairing
60 Starboard mainwheel
61 Oil cooler leading-edge intake
62 Undercarriage pivot
63 Brace strut
64 Leg brace fairing
65 Mainwheel oleo leg
66 Port mainwheel
67 Mainwheel outboard fairing
68 Torque link
69 Wing skinning
70 Aileron trim tab (port wing only)
71 Port aileron
72 Port wingtip

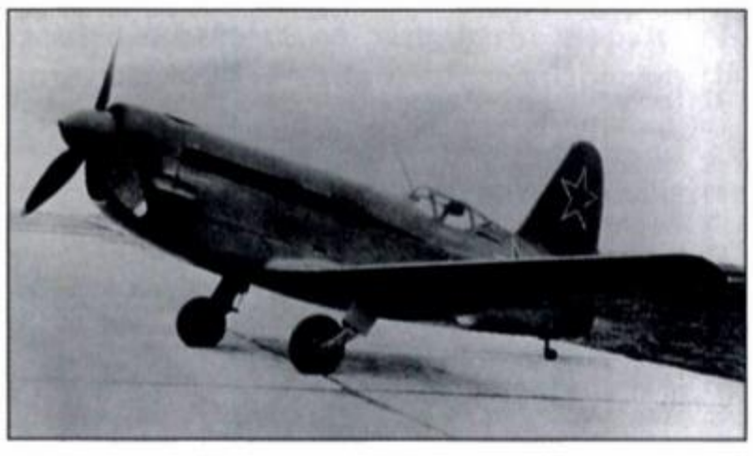
Mikoyan-Gurevich I-250/MiG-13



In a full-power dash, the VRDK compressor in the I-250/MiG-13 was operated via a clutch which diverted power from the Klimov VK-107R piston engine. Fuel was fed to burners and ignited by plugs, hydraulic rams opening the variable nozzle 'eyelids' beneath the rudder.

The crash programme to build a high-speed combat aircraft to counter the potential threat posed by the Luftwaffe's jet aircraft produced the Su-5 and, from the Mikoyan-Gurevich OKB, the I-250. Two prototypes (below and below middle) were followed by 16 production aircraft (notable for their larger tailfins), designated MiG-13 (bottom). These saw service briefly with the AV-MF near Riga from 1948 to 1950.





As a result of the wind tunnel tests, another wing, featuring new laminar-flow airfoils developed by TsAGI, was built at the design bureau. When flight tests of the first prototype were interrupted by engine failure, the engineers took the opportunity to install the new wings; testing resumed in August.

Calculations predicted a 90-km/h (56-mph) increase in top speed with the VRDK booster working. The required maximum speed at 7800 m (25,591 ft) was 810 km/h (503 mph) and 767 km/h (477 mph) at 4350 m (14,271 ft). Test pilot G. Komarov reached a speed of 793 km/h (493 mph) at 4350 m (14,271 ft) with the VRDK operating, which was 25 km/h (16 mph) better than required. Flight tests were interrupted for a second time when the engine failed again; this time, they were not resumed because of the unavailability of compressors and VK-107A engines.

By then, it was clear from the success of pure-jet aircraft already flying that a configuration of mixed-power with piston engines had no future, and the Soviet military leaders reassigned priority to pure jets. In the event of any delay in the development of a Soviet jet fighter, however, the MiG-13, not the Su-5, was chosen as a stop-gap solution.

MiG's pure jet stop-gap

Until February 1944, the Mikoyan-Gurevich (MiG) OKB had concentrated on the aerodynamic improvement of piston-engined fighters in their efforts to achieve higher maximum speeds and had avoided experimenting with ramjet and rocket boosters. This resulted in some beautiful fighter prototypes, such as the I-220, I-221 and I-225, but none of them saw production. However, the MiG OKB was now instructed to build a jet fighter.

As recounted earlier, MiG and its rival Sukhoi had each opted to use the VRDK jet booster with the Klimov VK-107R as the main engine. Essentially a VK-107A, this engine was rated at 1,650 hp (1230 kW) for take-off and fitted with an auxiliary gearbox for the VRDK's compressor. More than 95 per cent of the total power was transmitted by the engine's reduction gear to the 3.1-m (10-ft 2-in) AV-5B propeller to facilitate take-off.

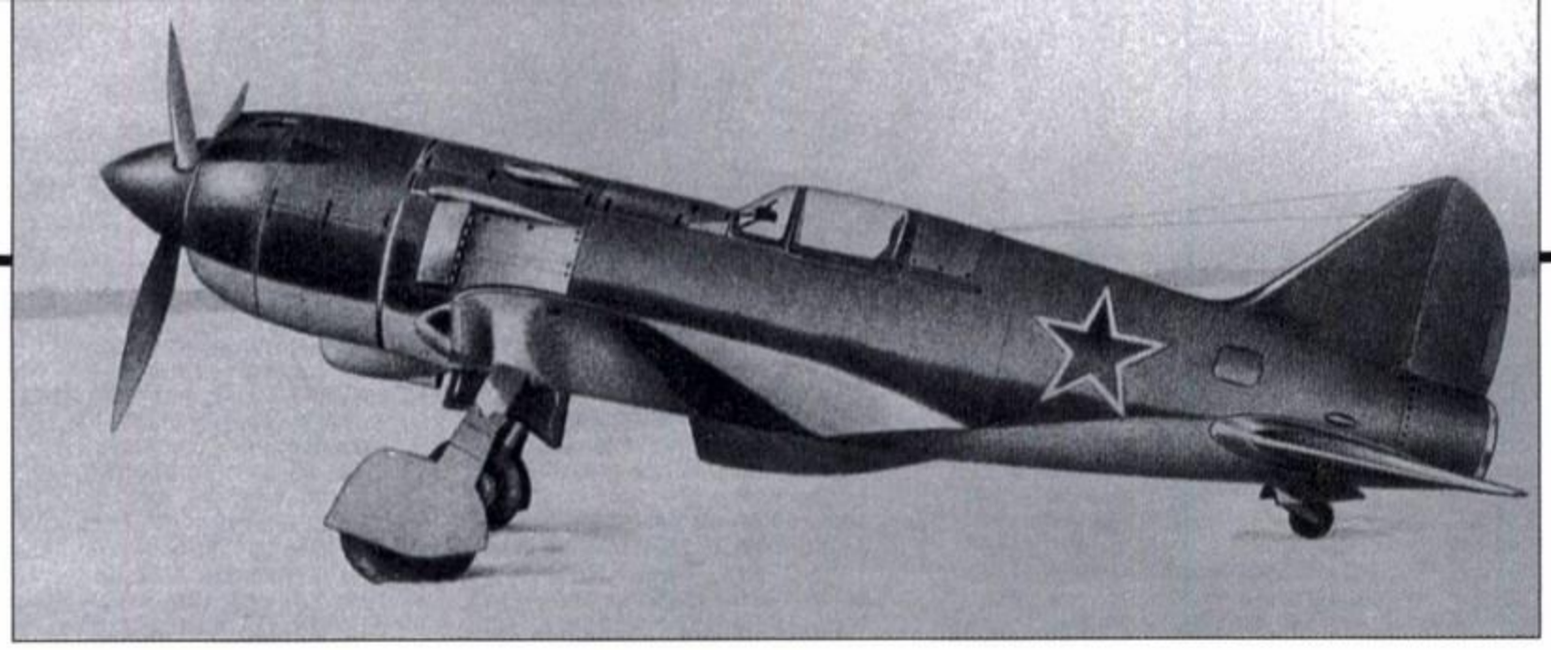
To attain maximum speed a clutch behind the crankshaft was engaged, driving a step-up gearbox (gear ratio 13:21 or 0.62) to a shaft which transferred power to the compressor situated in a large duct in the lower fuselage. Air, some of which was bled to the oil cooler, reached this duct from an inlet under the spinner and was also used to cool the main radiator located immediately behind the compressor. A secondary pipe in the top of the duct led some air to the main engine's supercharger. When power was transmitted to the compressor, the airflow was vastly increased and the increased pressure in the secondary upper pipe also boosted the piston engine's output. As the air flowed through the main duct it was mixed with petrol sprayed from seven nozzles and ignited by spark plugs. At this stage, the duct expanded to form a combustion chamber fabricated from welded stainless steel. Despite the extra weight imposed by the use of steel, aluminium for the ducting would not have withstood the intense heat and corrosion generated by the combustion process.

To reduce wall temperature and protect the fuselage, water from a 78-litre (17-Imp gal) tank was sprayed over the duct, with the added bonus that the steam augmented the thrust. The accelerating jet of high-velocity gases exited through two hydraulically-actuated nozzle eyelids. In cruise flight these eyelids closed the nozzle, acting as a fairing in order to reduce drag. It was estimated that at 7000 m (23,000 ft), the system produced 2,500 hp (1865 kW) of which 1,350 hp (1007 kW) originated from the booster.

While the VRDK had been extensively bench-tested, it could not be flight-tested until either the MiG or the Sukhoi fighter had been completed. In the event, it was the Mikoyan aircraft which took to the air first.

Known in-house as 'aircraft N', the all-metal MiG-13 prototype was of stressed-skin construction with welded steel tubing restricted to the engine cradle. A 10 per cent TsAGI laminar aerofoil was used for the wings, each of which had two spars and plate ribs. No slats were fitted but there were slotted TsAGI flaps, with two-section Frise ailerons outboard of them. The fuselage was built in three sections: an engine compartment with removable cowling panels, a centre fuselage which included the cockpit, and a short rear fuselage, attached to which was a detachable tail unit. Fuel was carried in a 415-litre (91-Imp gal) fuselage tank and two 100-litre (22-Imp gal) wing tanks, all made of self-sealing rubberised fabric.

A curious feature of the main landing gear was that the levered-suspension arms carrying the wheels were ahead of the oleo legs (i.e., the main gear had leading arms rather than trailing arms) and the wheel well doors were closed at all times except when the gear was in transit. The Mikoyan OKB proudly claimed it was the first time this had been accomplished in the USSR. A small castoring tailwheel retracted into a fairing positioned under the jet outlet.



Nikolay Polikarpov's last-but-one radial-engined design (for he died in July 1944), the I-185 failed to enter production – the Lavochkin La-5 employed the same M-82 engine, but consumed less of the precious Duralumin in its manufacture. Before the I-185 programme was finally cancelled in early 1943, a jet- or rocket-boosted variant was proposed, seen here in an artist's impression. Few details of the variant appear to have survived.

The location of the large fuel tank at the C of G required the cockpit to be positioned aft of the wings in similar fashion to the first MiG fighters. Stressed-skin construction was also used for the tail assembly and the port elevator incorporated a trim tab.

In 26 October 1944 a detailed mock-up was approved. Painted white overall, the first prototype, known as 'aircraft N No. 1', was rolled out on 26 February 1945. Its armament consisted of three 20-mm ShVAK B-20 cannon with 160 rounds per gun, one firing through the propeller hub and the other two, located on each side of the engine crankcase, synchronised to fire through the propeller.

OKB test pilot A. P. Deyev made the first flight on 3 March 1945. With the VRDK in operation the aircraft was extremely noisy, but was said to be 100 km/h (62 mph) faster than other piston-engined fighters. In mid-May Deyev pulled excessive *g*, overstressing the aircraft and causing tailplane failure, and was killed in the ensuing crash.

The second prototype, 'aircraft N No. 2', painted dark blue with a yellow horizontal streak, flew for the first time in late May, without armament. It was initially piloted by A. P. Yakimov of LII (*lyotno-ispytahtel'nii institut* - Flight Test Institute) who was later joined in the flight test programme by OKB pilots A. N. Chernoburov and I. T. Ivaschchenko. The fighter showed inadequate yaw stability, which was remedied by extending the leading edge of the fin to increase chord. A redesigned tailwheel strut was fitted to eliminate the need for the ventral tail fairing. Unfortunately, the aircraft was damaged beyond repair when Chernoburov attempted a forced landing.

In June 1945 the OKB was ordered to build 10 aircraft for the flypast over Red Square in Moscow on October Revolution Day (7 November). All the aircraft were built in time but the air parade was cancelled because of bad weather, thus saving Muscovites from the ear-splitting roar of 10 VRDK engines passing overhead at an altitude of a few hundred feet.

An order was placed in late 1946 by the AV-MF (*aviahtsiya voyenno-morskovo flota* – the Naval Air Arm) for 16 I-250s (this was a parallel designation applied to the second prototype). They were to be manufactured at factory No. 381 in Moscow. The production aircraft incorporated a few small changes in comparison to the second prototype, including a propeller with slightly curved, sabre-shaped blades which were later replaced by standard AV-5B blades. Other changes involved increasing the height of the fin and rudder, enlarging the wing fuel tanks and the water tank, and adding an RSI-4 radio. Its wire antenna stretched from the radio bay located immediately behind the cockpit to the top of the fin and then ran to a mast projecting diagonally forward from the top of the windscreen frame.

Factory tests were completed by the end of July 1947 and testing at NII VVS (*nauchno-issledovatel'skiy institut voyenno-vozdushnykh seel* – Air Force Research Institute) was carried out by Ivan M. Sukhomlin between 9 October 1947 and 8 April 1948. Bearing the service designation MiG-13, the aircraft were delivered to the Baltic Fleet base at Skulte near Riga, Latvia, and served with both the Baltic and Northern fleets until 1950.

500+ mph top speed

The MiG-13's top speed with booster was 825 km/h (513 mph) at 7000 m (23,000 ft); it had a range of 920 km (572 miles) with the booster used at its maximum duration of 10 minutes and 1380 km (858 miles) without it. Its service ceiling was 11960 m (39,000 ft) and the climb to 5000 m (16,400 ft) took 3.9 minutes.

Some time before the appearance of the I-250 (MiG-13) and Su-5, the famous aircraft designer Nikolay Nikolayevich Polikarpov developed a mixed-power version of his unlucky I-185 fighter (which, incidentally, was a stepping-stone to the La-5). Unfortunately, no documents survived on this machine, except a three-view drawing showing the overall dimensions and external features. The aircraft had a large air intake under the fuselage at the wing trailing edge (reminiscent of the radiator bath on the North American P-51 Mustang) and a very large nozzle; one can only speculate whether the project envisaged a motor compressor engine or a liquid-fuel rocket motor. The stabilisers were set somewhat lower than on the original I-185, the vertical tail was modified and the spine was somewhat fatter, probably housing extra fuel and necessitating a redesign of the canopy. Judging by the shape of the radial engine cowling, the project was based on the definitive M-82-powered version of the fighter, not the original M-71-powered version.

Mixed-power fighters could never challenge the performance of pure jets, but their development gave Soviet designers valuable experience in producing high-speed aircraft and, much later, ramjet and rocket engines for missiles. With the benefit of hindsight, it is apparent that the USSR would have been better served if its aviation designers had concentrated on turbojets. Its failure to develop a satisfactory turbojet engine has to be seen in the light of circumstances of the time. In 1941 not only was the Soviet air force decimated by the Blitzkrieg invasion, but the majority of aviation industry factories were either overrun or in immediate danger and were evacuated to a safe location east of the Urals. This upheaval coincided with the need to maximise aircraft production, but such a monumental task – one of the greatest accomplishments of any country during the war – could only be performed at the cost of a reduced research effort.

In retrospect, one item that stands out in the history of mixed power flight in the Soviet Union is the courage of the test pilots who bravely sat in front of a pressurised tank of concentrated nitric acid while their wooden aircraft spurted fire from its tail. They were truly men of steel flying plywood aircraft.

A. Dexter and Yefim Gordon

US mixed-power – the Ryan FR-1

In an attempt to combine the advantages of jet power (speed and excellent high-altitude performance, for example), but avoid some of the disadvantages associated with early jet designs (long take-off runs, high fuel consumption and throttle 'lag'), the US Navy decided in late 1942 to pursue a mixed-power solution to fill a requirement for a high-performance fighter able to operate from small escort carriers. Proposals were received from nine manufacturers, Ryan Aeronautical Corporation of San Diego being awarded a contract for three prototypes in February 1943. A low-wing monoplane with tricycle undercarriage, the Ryan Model 28 sported a standard 1,425-hp (1063-kW) Wright R-1820 radial in the customary position, ahead of the pilot, while a General Electric I-16 turbojet (military designation J31-GE-3) was mounted in its tail, fed by air intakes in each wingroot and tuned to burn the same fuel as the piston engine. The first XFR-1 flew in June 1944. Production contracts for some 1,300 production Fireballs were placed, but the end of World War II brought mass cancellations and only 66 were completed. A number were engaged in service trails with VF-66, and later VF-41 (redesignated VF-1E on 15 November 1946), the latter unit making the first 'all-jet' landing (albeit by a mixed-power aircraft) on an aircraft-carrier (USS *Wake Island*) on 6 November 1945. By early 1948 these aircraft had been relegated to ground instruction status, the mixed-power concept having given way to the 'pure jet'.

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